JUNE • 1955

PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

- What's ahead in jet fuels?
- Series on absorber design starts this month
- A new tool for analyzing investments

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Distinctively at home, driving a line of oil refinery pumps, are Elliott steam turbines. These modern prime movers are designed to insure low-cost, efficient service — easy maintenance — and long-lasting 24 hour-a-day dependability. They're available with a range of capacities and speeds up to 2000 hp and 7000 rpm. For details contact your Elliott representative, or write to the Elliott Company, Steam Turbine Department, Jeannette, Pa.

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Volume 34, No. 6 June, 1955

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A Quick Look
at This Issue

These handy digests permit checking ✓ those articles you want to read first.

WHAT'S AHEAD FOR JET FUELS

☐ **Military Calls Jet Fuel Signals . . .** Defense Department requirements mean spectacular gains in jet fuel demand during the next few years. Though two commercial airlines will have started turbo-prop service by the end of the year, military will dominate jet fuels pictures for years to come. JP-4 specification fuel overshadows other grades for the military. **Page 110.**

☐ **Kerosine or JP-4 for Commercial Jets . . .** This question is getting major consideration from everyone in aviation development. Both specifications are available and about the same cost in a given area. West Coast prices will be somewhat higher than Gulf Coast tags. **Page 112.**

☐ **Vapor-Phase Hydrodesulfurization . . .** Ten years of plant operation show this process can be applied to cracked naphthas and light straight-run intermediates with a good payout. Cost estimates are compared with acid-treating and show favorable returns even if you presently have acid-treating facilities. Performance data are presented for extensive commercial operation. **Page 118.**

☐ **Absorption and Stripping Design . . .** From the files of a process engineer comes this method for engineering accuracy in the process design of absorption and stripping units. Unlike other design methods, it treats the absorption and stripping systems as one unit. Part 1 gives the basis for the method. **Page 123.**

☐ **Foundations for Vertical Vessels . . .** New thoughts and procedures for design of foundations for vertical vessels are always of help to the designer. From a wealth of experience, the author presents a complete, well-reasoned treatment of this common design problem and offers time-saving tips never before published. **Page 127.**

→ Now Turn the Page →

A Quick Look at This Issue

☐ **How to Determine Physical Properties for Complex Petroleum Fractions . . .** This article was prepared especially for the young engineer. Here is the method of obtaining molecular weights, critical properties, thermal properties, etc., for these special substances. The author lists the sources for these data. Learn now to use the characterization factor method for these properties. Turn to **Page 136.**

☐ **Evaluating Economics by Nomograph . . .** Economic calculations are now a part of most engineers' regular duties. The author has answered the challenge of finding a rapid accurate method for making this type of calculation. The article is a sample calculation displaying the use of the nomograph for economic evaluations. **Page 139.**

☐ **Analyze Investments With This Tool . . .** Here's a convenient method for presenting to management the risks contingent on a proposed investment. Using statistical methods, the author has developed risk curves and a useful nomograph on a typical problem—the purchase of a coking process. **Page 143.**

☐ **Radioactivity—New Tool For Refiners . . .** Radiation technology has come into its own as a brand new tool for refiners. Industrial applications are clearly described from both the equipment and application standpoints. To be really in tune with recent developments, this is "must" reading for you. **Page 150.**

☐ **Houdresid Process Cracks Residua . . .** Using equipment similar to Houdriflow, this new method cracks heavy recycle gas oil to extinction. By converting crude residua to high quality distillate products, the disposal of heavy fuels is taken care of. Novel process features eliminate the adverse effects on product selectivity resulting from heavy metals in the feed. **Page 153.**

☐ **Relaxation Methods in Refinery Design . . .** Here's a new approach to handling the mathematics involved in complicated refinery design problems. It's the "Southwell Relaxation Method" of computation, which the author applies to a typical problem to demonstrate its application to refinery design. This procedure can be used to solve many difficult engineering problems without resorting to higher mathematics. For an explanation of the method and an example of its use, turn to **Page 157.**

☐ **New Developments in Hydrogenation . . .** Here is a review of the work done in Germany on catalytic pressure hydrogenation of petroleum. It traces the development of new catalysts for this work and gives an insight into the tremendous amount of effort being put forth in improving their technology. **Page 161.**

☐ **Predicting Grease Viscosities . . .** A nomograph for calculating and predicting the apparent viscosity of greases at low temperatures is a useful tool to the grease manufacturer. Such a nomograph is presented in this article along with a description of the equipment used for an apparent viscosity determination. **Page 165.**

☐ **How to Choose Materials of Construction for Ammonia Synthesis . . .** The big problem is not how to make ammonia but how to prevent hydrogen and nitrogen attack during the processing. What types of metals will prove satisfactory for these severe services? What alloys should be used under various conditions? Your answers on **Page 169.**

☐ **Hydrogen—Its Markets and Uses . . .** Completion of the current expansion in catalytic reforming facilities will make available great quantities of high-purity hydrogen. Not all of it can be utilized for ammonia manufacture, since that field shows signs of oversupply. Here is a roundup of the market situation and the potential uses for this hydrogen. **Page 171.**

☐ **Tide Water Modernizes Electrical System . . .** Electrical power distribution systems must keep pace with other phases of refinery modernization and expansion. Here is the story of the modernization of the electrical system of a large West Coast refinery. Many valuable tips starting on **Page 173.**

☐ **How to Analyze DEA Solutions . . .** Here are some tips on how to keep tab on the diethanolamine solutions used in hydrogen sulfide removal. The analytical studies made by this company indicate that there are many interfering ions which should be considered in setting up a testing schedule on rich and lean solutions. **Page 177.**

☐ **Control Hazards in Confined Areas . . .** Few tasks pose the number or variety of dangers encountered by the maintenance man. His safety and that of others in the vicinity depend upon recognition of these hazards and the prompt application of safety practices. **Page 108.**

☐ **How Annual Reports Are Judged . . .** Last month the author took you step by step through the intricate task of preparing your company's most important yearly document—the annual report. In this, the concluding installment of his series, he gives some no-less-helpful hints on the good and bad elements that crop up in annual reports. **Page 211.**

☐ **Supply-Demand Balance Must Be Achieved . . .** Major problems now facing industry management concern both the current situation and the longer term outlook. Failure to pay proper attention to supply-demand balance, thus causing temporary gluts, may cause a long-range famine. **Page 221.**

☐ **Texas Has New Labor Laws . . .** The Texas Legislature has adopted new laws on labor, unemployment compensation and other topics of major concern to the oil industry. **Page 234.**

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PETROLEUM REFINER and The REFINERY CATALOG for the refining-natural gasoline-petrochemical industry

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Distillation Topics For July

ARE YOU INTERESTED in distillation? If you are then be sure not to miss the July issue of the PETROLEUM REFINER.

We are bringing to you in that issue a group of articles highlighting this important subject. New methods, new approaches, new developments, new data all are included. There is a good one on empirical methods of calculating the slot area in bubble caps. Then there's another on efficiencies and pressure drops in sieve columns. Also there will be presented a new method for computing the minimum stages for separations. You'll also want for your files a new approach to tray design.

We know you'll like them.

Symposium— And No Drinking

WHAT IS A symposium?

And did you notice that we did not mention the word *symposium* in the above paragraph on *distillation*.

The words *distillation* and *symposium* are much closer related than most of us seem to realize. The word symposium comes from *syn* (with) and *posis* (a drinking). Therefore the word means a drinking party. Of course when we use the word symposium nearly every month we are referring to another definition, "a collection of opinions on a subject, especially one such assembled and published by a periodical."

We will continue to have for you a symposium (or a special issue) each month. And we'll try to keep them current and pick out the interesting subjects. If you have any pet topics you'd like to have us consider just advise.

Views and News— Readable, Valuable

Capsuled information which readers found both interesting and valuable made its initial appearance in March under the heading "A Quick Look at the Industry This Month," with a subtitle hailing it as "News and Views You Can Use." Busy people—and oil men are busy men—like this type of data. There's no doubt about that.

With the groundwork well handled in previous issues, we present on pages 99 and 100 another compilation.

Get the habit of checking these items each month. They are done by specialists in their fields who study current developments and then present in compact, readable form bits of information that call for minimum reading time but frequently will offer views of value to you in your business.

A WORLD OF PRACTICAL KNOW-HOW
in the design, engineering, construction and installation of complete refineries, individual processing units and refinery modernization

CANADA — Complete refinery with capacity of 23,000 barrels per day.

ENGLAND — Largest refinery in Britain, with capacity of 125,000 barrels per day.

UNITED STATES — Synthetic ammonia plant, producing 180 tons of liquid ammonia per day.

What Foster Wheeler's

WORLD-WIDE EXPERIENCE

in petroleum processing

means to you

The sun never sets on Foster Wheeler petroleum processing plants. From U.S.A. to the Philippines — from England to South Africa — modern refineries and processing plants designed and installed by Foster Wheeler are producing, every day, high quality petroleum products for free-world consumption.

During the past year, FW has placed in operation complete new refineries in U.S.A., South America, South Africa and the Philippines — plus many additional processing units including the largest crude distillation unit ever built and the highest capacity fluid cat cracker in the world. Work is continuing on similar projects in Brazil, Venezuela, England, France, Spain, Bahrein, Canada and the U.S.A. These worldwide operations are conducted jointly by Foster Wheeler and their subsidiary companies in Canada, England and France.

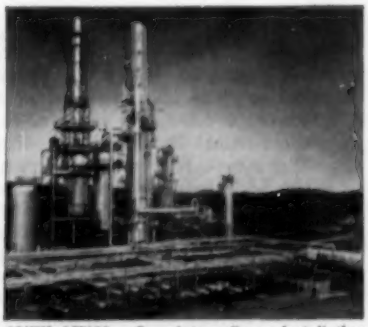
The *experience* which all of this represents is of vital importance to petroleum refiners *everywhere*. It means that virtually every forseeable design and construction problem has already been solved under a variety of conditions. Working with and training unskilled labor in far countries has developed streamlined and simplified construction procedures. And this specialized know-how is constantly being expanded, through research and development, to encompass the latest technological advances in the petroleum and chemical processing fields.

This valuable experience can save you time, effort and expense in any phase of refinery design, construction or modernization. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

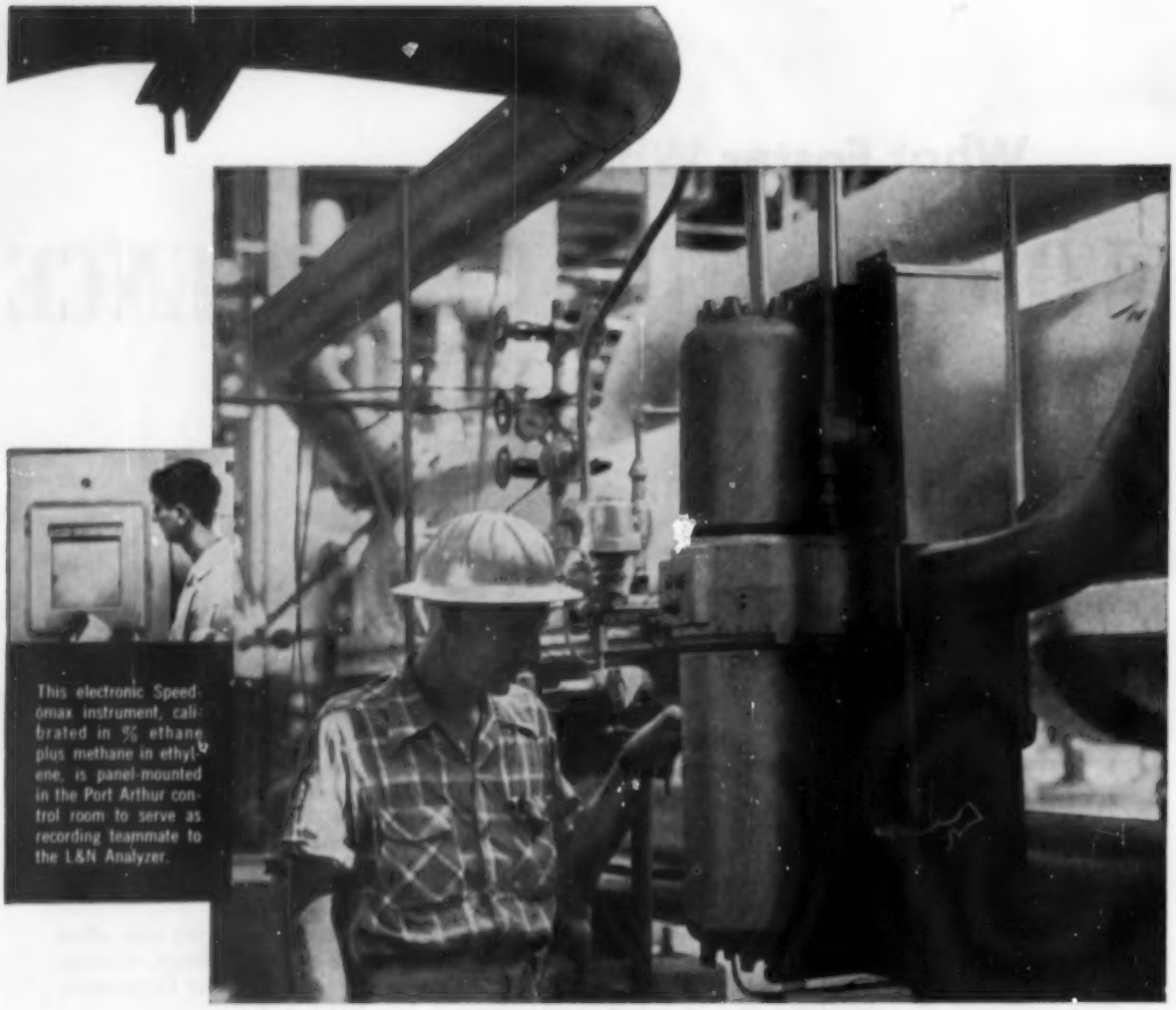
COLOMBIA, S. A. — Completely modernized refinery with capacity of 30,000 barrels per day.

PHILIPPINES — Complete refinery with capacity of 13,000 barrels per day.



SOUTH AFRICA — Complete refinery installation — capacity, 15,600 barrels per day.

For more data on advertised products, use Readers' Service Cards, last page.



This electronic Speedomax instrument, calibrated in % ethane plus methane in ethylene, is panel-mounted in the Port Arthur control room to serve as recording teammate to the L&N Analyzer.

Infrared analysis helps Gulf to pipe "on spec" ethylene directly to consumers, without tankage or sampling

There's no costly storage—no laborious sampling or blending before shipment of the high-purity ethylene produced at Gulf Oil's Port Arthur Refinery. Operators are *certain* that the plant stream is always "on spec", as it runs from production directly to pipelines serving the ethylene-hungry industries of the Houston—Sabine River—Port Neches area.

One reason for such confidence in product quality is the L&N Infrared Analyzer that Gulf has installed to constantly monitor impurities in the ethylene stream. Should the sensitive Analyzer detect a predetermined percentage of impurity, operators can promptly divert "off spec" stream before "on spec" product in the lines can be contaminated.

Even though subjected constantly to the vibrations of a pipeline mounting, and electrical pick-up from pumps and compressors, the Analyzer checks consistently with daily spectrometer analyses—a tribute to the L&N instrument's all 'round dependability.

The Analyzer's prominent role at Port Arthur is duplicated in many other successful applications of this versatile instrument. It's measuring CO and CO_2 in the steel industry—SO_2 in H_2SO_4 stack gas—methane build-up in ammonia production—isobutane loss in petroleum. It may well be the yardstick *you* need in your own gas measurements.

Our Applications Lab is staffed with specialists glad to discuss your use of infrared. Outline your requirements, without obligation, in the Infrared Analysis Data Sheet we'll mail on request. Or, just write for our Demonstrator, "How the L&N Infrared Gas Analyzer Works." The address is Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

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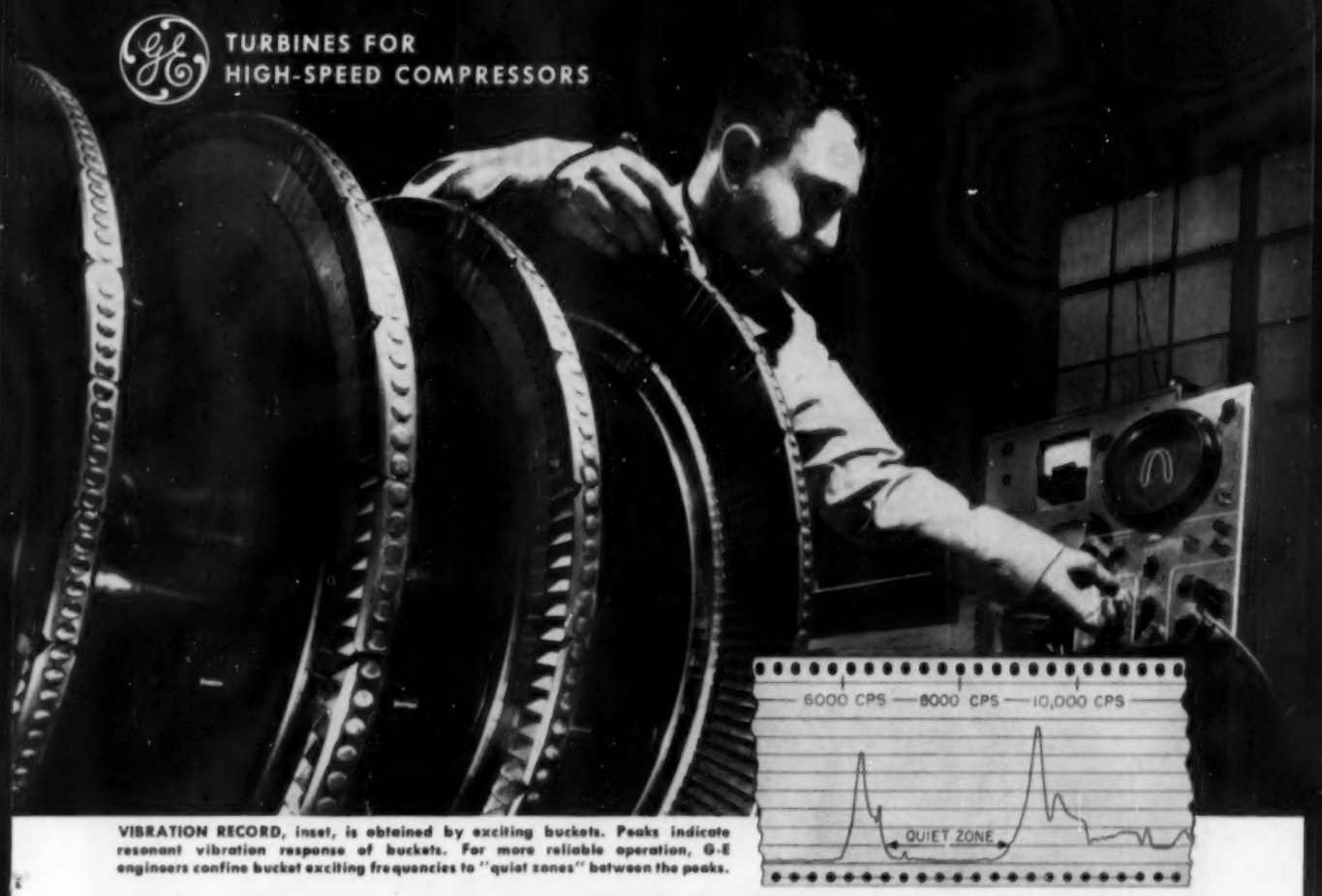
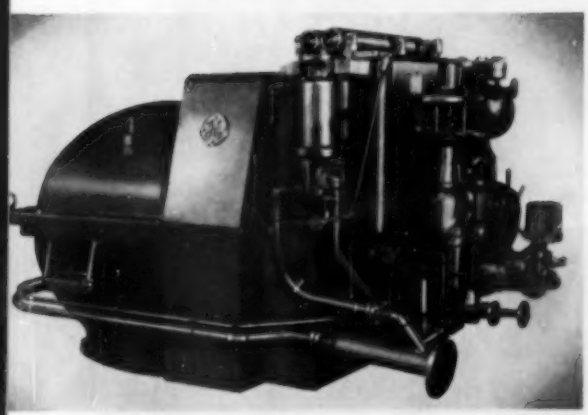
instruments — *automatic controls • furnaces*

TURBINES FOR
HIGH-SPEED COMPRESSORS



VIBRATION RECORD, inset, is obtained by exciting buckets. Peaks indicate resonant vibration response of buckets. For more reliable operation, G-E engineers confine bucket exciting frequencies to "quiet zones" between the peaks.

How G-E Engineers Locate "Quiet Zones" for Safer High-speed Turbine Operation



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

When driving modern compressors and blowers, G-E high-speed turbines spin at operating speeds of 7000 rpm and up. At such speeds, if resonant vibration were not controlled carefully, bucket fatigue failure might result.

HERE'S HOW General Electric combats the problem: Natural vibration frequencies of the buckets on each new turbine rotor are determined with the special equipment shown above—an oscillator, crystal pick-up, and high-speed level recorder. "Quiet zones" of minimum normal vibration are clearly revealed.

With this information available, the number of nozzles can be varied so that steam striking the buckets will create vibration-exciting frequencies only in these "quiet zones." By thus making sure that steam-impact frequencies don't coincide with critical natural frequencies, the chance of bucket failure is greatly reduced.

VIBRATION TESTING is one of many features that add to the reliability of G-E high-speed turbines. For more information, contact your nearest G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y. 241-2

Progress Is Our Most Important Product

GENERAL ELECTRIC

Which of these 22 tube steels will give you maximum tube life per dollar? *Ask the experts!*

This month's report is on: **2% CR.-MO.**

Has intermediate corrosion resistance in combination with good creep strength and fair resistance to oxidation. For use at temperatures up to 1200° F. in cracking coils, reforming units, heat exchangers, vapor line and hot oil piping, and return-bend forgings for oil heaters.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

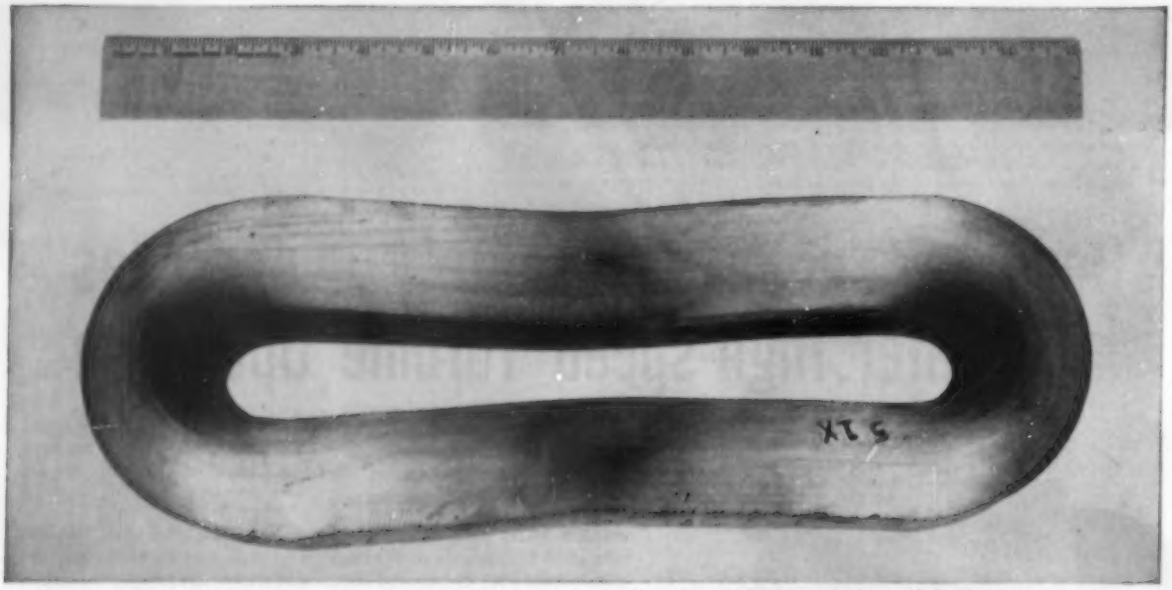
Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

* *Available as seamless tubing on an experimental basis only.*
** *Not available as seamless tubing.*

FOR every high temperature application, there's one tube steel that gives you the best life-cost ratio. One steel best answers your particular set of temperature-pressure-corrosion-oxidation conditions. That's why the Timken Company makes the 24 different high temperature steels shown in the box at left.

To find the one best steel for each of your applications, ask the Timken Company metallurgists. They're experts. They know how to balance the various factors against cost—and recommend the analysis that gives you maximum tube life per dollar of cost. They've been doing it for 20 years. And remember—regardless of analysis, you get uniform quality in every Timken® tube because we rigidly control quality at every step from melt shop through final inspection.

Put our "RSQ"—Research, Supply, Quality—to work on *your* tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".



Flattened test of 10¼" O.D. by 1.580" wall of 18-8 Cb showing the excellent ductility of large, heavy-wall Timken seamless tubing.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

balanced...

WITH HIGH PORE VOLUME

Aerocat® fluid cracking catalyst

For highest cracking efficiency—we have carefully balanced the new high pore volume with pore diameter, particle shape, particle size distribution and hardness.

The result is the first truly balanced catalyst offered for optimum performance in fluid catalytic cracking units.

Cyanamid was first to deliver a *high pore volume* catalyst.

For further information, ask your Cyanamid representative about AEROCAT Fluid Cracking Catalyst with high **PV.**

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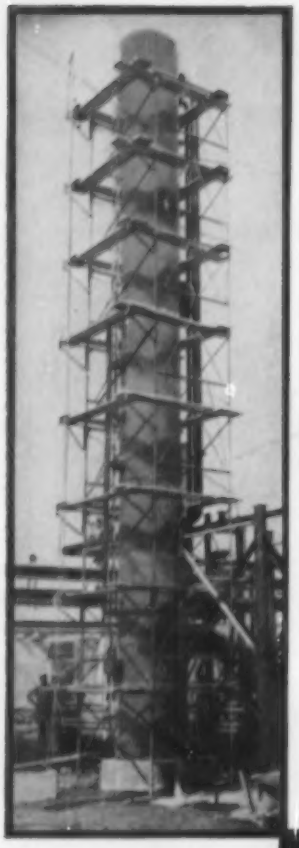
For more data on advertised products, use Readers' Service Cards, last page.

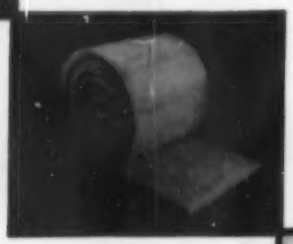


New insulating method saves hours and hours on tanks and towers!

Imagine wrapping tanks and towers with a lightweight, flexible insulation that fits any curved or flat surface—instead of laboriously building up rigid insulating materials, block by block. Imagine further that the new method requires almost no cutting or fitting time, no expansion joints or welded rings, no pointing up.

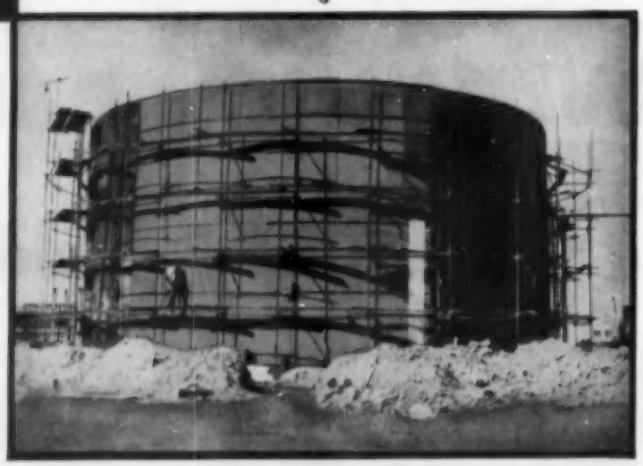
Then imagine how much time and money this method would save you—and at once you'll see the advantages of using ULTRALITE long glass fiber insulation blankets. It is easily applied and easily finished with weather-proofing materials. Savings are truly worthwhile, as proved time and again on oil storage tanks, asphalt truck tanks, fractionating columns, reboilers, blending tanks, etc. (And for hot or cold piping, savings are just as substantial when you use our new G-B Snap*On pipe insulation—a one-piece molded pipe insulation of fine glass fibers.)

No damage from water . . no heat loss from "fluing action" . . . no problems when repairs are necessary—for Ultralite is resilient, reusable, won't absorb moisture.



ULTRALITE

the long glass fiber insulation



Write today for
"How-To-Do-It" specifications
and name of your nearest Ultralite distributor

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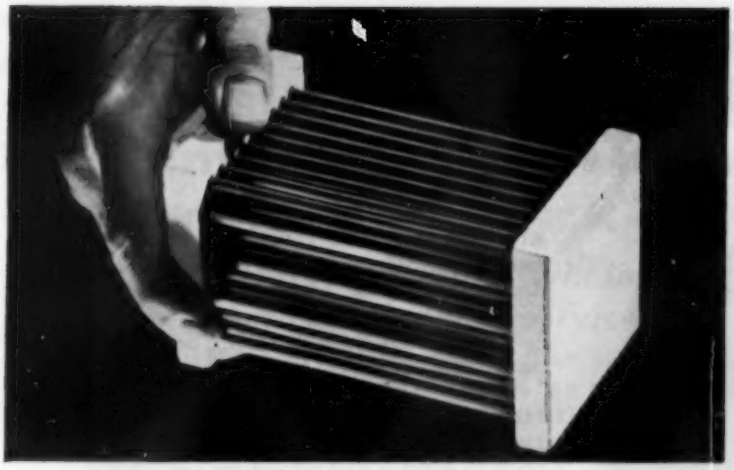
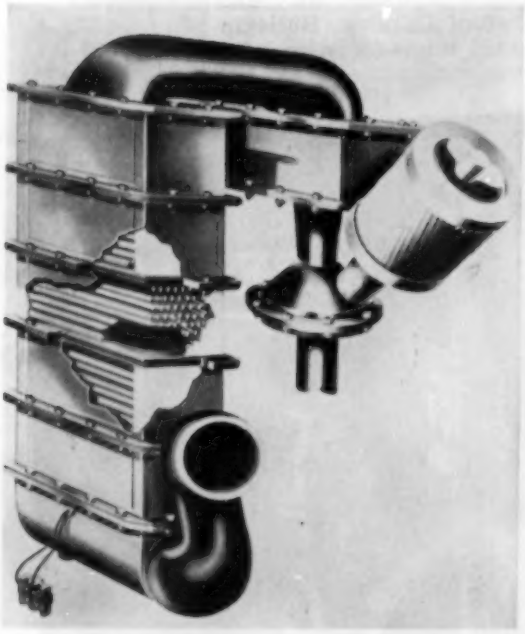
For more data on advertised products, use Readers' Service Cards, last page.



This new combustion catalyst, the oxycat, controls air pollution and creates energy and power by recovering waste heat. Porcelain rods (by Frenchtown Porcelain Company, Frenchtown, N.J.) are largely made of ALCOA Alumina to provide high resistance to thermal and mechanical shock. Rods are coated with a catalytic agent of ALCOA Activated Alumina and platinum.

In typical installations, oxycats are mounted in exhaust stacks of furnaces, drying ovens, incinerators, or any industrial processes where combustible gases are exhausted. Waste gases flow across rods. Combustion occurs at catalytic surface. Heat released by this exothermic reaction can be returned to the oven, converted to steam or used in other processes. Catalyst removes practically 100% of pollutants from gas streams.



Oxy-Catalyst catalytic exhaust, working on the same principle, ends dangerous exhaust fumes and odors from internal combustion engines. Made to take the place of standard mufflers, OCM is easily installed in gasoline, diesel or LPG-powered equipment.

Now ALCOA ALUMINA turns exhaust gases into energy instead of smog

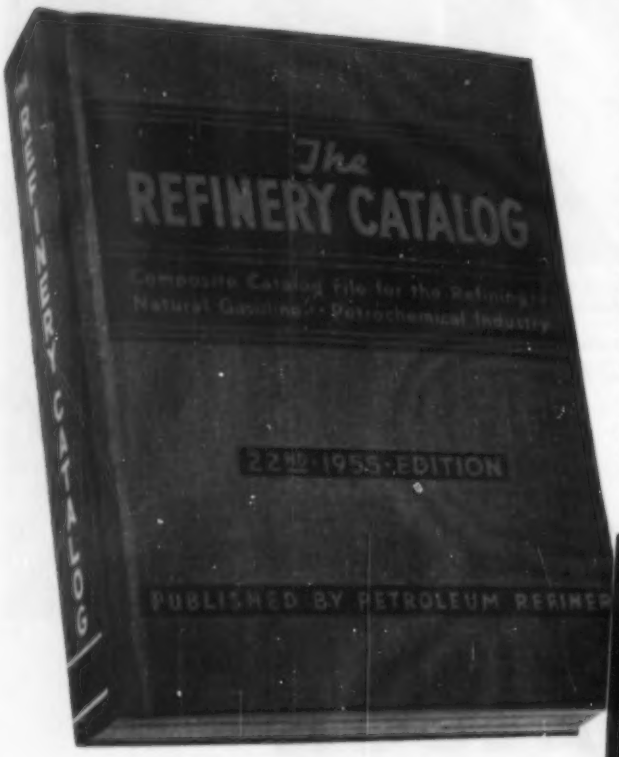
Oxy-Catalyst, Inc. of Wayne, Pa., has put ALCOA Alumina to work eliminating air pollution and inefficient combustion, all in one operation.

In their new oxycat and OCM exhausts, ALCOA Alumina is part of the porcelain rods and catalytic coating. Used in the porcelain because it is highly inert and chemically stable, ALCOA Alumina does not interfere with the chemical reaction of the catalyst. In the coating, ALCOA® Activated Alumina provides extremely active oxidation maintained over a wide range of temperatures. It is very resistant to poisoning and highly efficient over a long period of time.

ALCOA Aluminas are remarkably versatile wherever they are used . . . with hundreds of applications in catalysis, desiccation, refractories and ceramics. Put ALCOA Aluminas to work *for you.* Write for samples of alumina to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-F Alcoa Building, Mellon Square, Pittsburgh 19, Pennsylvania.

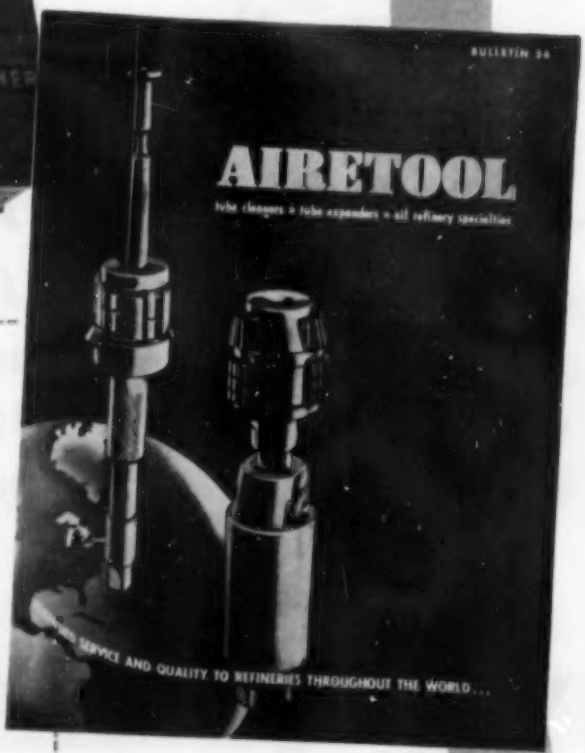
ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

20 pages of facts and figures on AIRETOOL in the new REFINERY CATALOG...


The
REFINERY CATALOG
Composite Catalog File for the Refining, Natural Gasoline & Petrochemical Industry
22nd 1955 EDITION
PUBLISHED BY PETROLEUM REFINER

You are sure to find information that will help you solve your tube maintenance problems through efficient and profitable use of Airetool equipment. See pages 85 to 105 of the new 1955 REFINERY CATALOG. They're packed full of useful information.

In the Catalog you will note that facilities of the Airetool Engineering Department are available to provide prompt service and advice on any of your tube maintenance problems. Product development experience, latest equipment designs, together with the facilities of research provide the answers to many general and specific problems. An index of the Airetool Catalog, Bulletin 56, is printed below for your information.


BULLETIN 56
AIRETOOL
tube cleaners • tube expanders • all refinery specialties
SERVICE AND QUALITY TO REFINERIES THROUGHOUT THE WORLD...

INDEX OF AIRETOOL BULLETIN 56 INFORMATION

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Consult the REFINERY CATALOG for details on tube maintenance

AIRETOOL is everywhere... wherever oil refineries demand efficient tube maintenance equipment and quick service

New Netherlands plant will improve European facilities and service

Twenty-five years of growth and expansion are accurate gauges of a product's merit and acceptance. Now, Airetool's new plant in Vlaardingen on the Neuve Maas Canal, near Rotterdam, is open to serve the increasing European need for Airetool tube expanding, tube cleaning and tube maintenance equipment. This is typical of the extent to which Airetool goes to better serve its customers. We believe our reputation as leader in the industry will be furthered throughout the world.

AIRETOOL TUBE CUTTER

This lightweight, easily portable internal tube cutter is indispensable—wherever small diameter tubes are used. Double self-centering hardened steel cutter blades quickly cut all steel or non-ferrous tubes, from ⅝" to 1" diameter. Features adjustable ball-bearing thrust collar, positive lever-controlled feed, eliminates chattering or binding. Smooth operating, powerful single-stage, air-driven motor provides easy cutting action.

AIRETOOL TUBE EXPANSION CONTROL SYSTEMS

Quality and precision-built for maximum efficiency in rolling tube joints in condensers and heat exchangers. Pre-set to roll uniformly tight, perfect joints every time, at production line speed. Assures maximum bonding. Automatic shut-off prevents "over-rolling."

AIRETOOL "6000" SERIES TUBE CLEANERS

Quickly removes even hardest deposits from straight tubes. Various cutter and knocker heads are available to fit the particular need. Features power-packed motors, with ball-bearing thrusts to drive fast-cutting Airetool Cleaner Heads at high speeds.

AIRETOOL G-400 EXPANDER

Rolls tubes to uniform tightness and maximum bonding—and through the full thickness of the tube sheet. Made of the best alloy steel, precision-machined to closest tolerances for best results and enduring service.

Renowned service and quality to refineries throughout the world...

BRANCH OFFICES: New York, Philadelphia, Chicago, Tulsa, Baton Rouge, Houston
REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, South America, England, Italy, Japan, Puerto Rico, Hawaii
EUROPEAN FACTORY: Vlaardingen, the Netherlands

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

equipment . . . . or write AIRETOOL for information

There's an Airetool tube cleaner and tube expander for *every* type of tubular construction.

For more data on advertised products, use Readers' Service Cards, last page.

GETTING THE BEST OF OIL !

PARSONS

When Esso Standard Oil Company wanted a distillation unit for lubricants production they selected The Ralph M. Parsons Company from competitive bidders to do the job. This plant has been in operation at Baton Rouge, Louisiana, for nearly a year.

By having Parsons handle mechanical design, procurement and construction, Esso gained all the advantages of working with a single organization with a single responsibility.

THE RALPH M. PARSONS COMPANY

ENGINEERS • CONSTRUCTORS

617 South Olive Street, Los Angeles 14, California

NEW YORK • TULSA • WASHINGTON

ANKARA • BAGHDAD • BEIRUT • KARACHI • NEW DELHI • PARIS

YOU USE BRICK TO BUILD A BUS

Behind everything that's made or moved lies the refractory brick that contains the flames, the enormous heats, of industry.

Without refractory brick, you'd see no bus in this picture. Nor any picture, for that matter.

Making refractories for the infinite requirements demanded of them is a precise and exacting science, stemming from vast resources of mines, minerals and laboratory control.

And General Refractories provides them from multiple plants and warehouses strategically located to serve industry swiftly . . . dependably . . . economically.

GENERAL REFRACTORIES CO.
Philadelphia 2

GENERAL REFRACTORIES

COMPLETE REFRACTORIES SERVICE

FOR THE PETROLEUM INDUSTRY . . .

LITECAST-50—A hydraulic setting light weight castable having a density of approximately 50 lbs. per cu. ft. Available in regular mix and pneumatic gun mix.

HIGH-STRENGTH BRIK-CAST—A hydraulic setting clay base castable having exceptionally high strength. Available in regular, pneumatic gun mix and trowel mix.

GREFCO CASTABLES are manufactured at 4 strategically located plants in Pennsylvania, Missouri, Texas, and California.

don't be left behind . . .

For more data on advertised products, use Readers' Service Cards, last page.

EVERY REFINER AND EVERY MARKETER REALIZES THE SIGNIFICANCE OF THE PRESENT TREND TO HIGHER OCTANES. It is a trend that predicts the future market demands for improved motor fuels to efficiently power higher compression automotive engines.

New methods . . . new techniques . . . new concepts in refining processes and equipment—all are necessary to adequately meet the refiner's needs in enabling him to produce a higher octane gasoline most efficiently and economically.

Cracking the octane barrier, Universal has provided Rexforming*—a process completely capable of solving the refining industry's most immediate and long-range problem.

In the final analysis, the refiner who can produce the products for which there is the greatest demand, and the marketer who can supply them will be building a sound economic position for the future.

Don't be left behind! Check

Rexforming

TRADE MARK

carefully . . . examine it in relation to your refining and marketing problems. Chances are that you will want to consider its immediate application to give you today's and tomorrow's octanes.

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U. S. A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service
Protects Your Investment

**Developed by the Pioneers of Platinum Catalyst Reforming*

For more data on advertised products, use Readers' Service Cards, last page.

Order now!

Ethanolamines

for industry

by NITROGEN DIVISION

. . . the name to watch in the petrochemicals field

Mono-, Di- and Tri-Ethanolamines are now being produced by Nitrogen Division in its spotless new Orange, Texas, plant. You can get Ethanolamines pure enough to meet each and every one of your process needs!

Call or write today for information, quotations, and technical assistance.

Order today for prompt delivery to any location.

NITROGEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

Anhydrous Ammonia • Ammonia Liquor • Urea
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Ethanolamines • Nitrogen Tetroxide • Ethylene Oxide
Ethylene Glycols • Methanol • Nitrogen Solutions
U.F. Concentrate–85 • Fertilizers & Feed Supplements

A very important page for your Chemical Data Book!

JEFFERSON CHEMICALS

Ethylene Oxide—A highly reactive chemical intermediate, for use as a starting material in the manufacture of acrylonitrile and nonionic surface active agents; a sterilizing agent and fumigant.

Ethylene Glycol—For use as a nonvolatile antifreeze; a heat transfer medium; a raw material in the manufacture of low-freezing dynamite; a starting material for the production of synthetic fibers and alkyd resins; a plasticizer; a constituent of hydraulic fluids; and a general solvent and chemical intermediate.

Ethylene Dichloride—For use as an ingredient of tetraethyl lead fluid, a fruit degreening compound and agricultural fumigant; a solvent for fats, oils and waxes; a metal degreaser; a spotting agent for textile cleaning; a chemical intermediate for use in resin manufacture and in other processes.

Diethylene Glycol—For use as a dehydrating agent for natural gas; a moistening agent for tobacco, glue and gelatin; a textile lubricant and coupling agent; a solvent in textile dyeing and printing; a constituent of hydraulic fluids; a heat transfer medium.

Monoethanolamine—For use as a gas scrubbing agent for recovery of hydrogen sulfide and carbon dioxide; a chemical intermediate in the manufacture of various surface active agents, rubber chemicals and other materials; a vehicle in the manufacture of antibiotics.

Diethanolamine—For use as an intermediate in the manufacture of surface active agents used in textile specialties, herbicides, petroleum demulsifiers, etc.; as a gas scrubber in refinery operations; as a rubber chemicals intermediate.

Triethanolamine—For use as an intermediate in the manufacture of surface active agents used in textile specialties, waxes and polishes, herbicides, petroleum demulsifiers, cosmetic preparations, cement additives, cutting oils, etc.; as a rubber chemicals intermediate.

Nonyl Phenol—For use as an anionic and nonionic surface active agent intermediate; as a starting material for the manufacture of lubricating oil additives, stabilizers, petroleum demulsifiers, oil-soluble phenolic resins and plasticizers.

Morpholine—For use in the manufacture of surface active agents, rubless waxes and polishes, rubber curing agents, corrosion inhibitors, antioxidants, catalysts, plasticizers, dyes, agricultural chemicals, separating agents, bactericides, pharmaceutical chemicals and textile lubricants.

Ethylene Carbonate—For use as a solvent for acrylonitrile polymers, lignin, nitrocellulose, nylon, vinylidene chloride-acrylonitrile copolymer, cellulose acetate and other polymeric materials; in the preparation of agricultural chemicals, resins, fungicides, pharmaceuticals and plasticizers.

Propylene Carbonate—For use in hydraulic fluids; as a solvent for cellulose resins, bisphenol resins and other polymeric materials; and as an intermediate in the preparation of agricultural chemicals, resins, fungicides, pharmaceuticals and plasticizers.

Glycerine Carbonate—For use as an intermediate in the production of glycidol; as a solvent for cellulose acetate, nylon, nitrocellulose and polyacrylonitrile; and as an extractive solvent in certain aliphatic and aromatic hydrocarbon separations. Available in trial lot quantities.

Polyethylene Glycols—For use in lotions and creams; vehicles for antibiotics, dentifrice active agents, antihistamines, antiseptics, fungicides, anesthetics, peroxides and sulfa drugs; lubricant for suppositories; and as an extender in cold hair-waving solutions.

Most products shipped in tank cars, tank wagons and 55-gal. drums. Write your nearest Jefferson office for technical information, availability and price schedules. Samples are available for your investigation.

"Essential Chemicals from Hydrocarbon Sources"

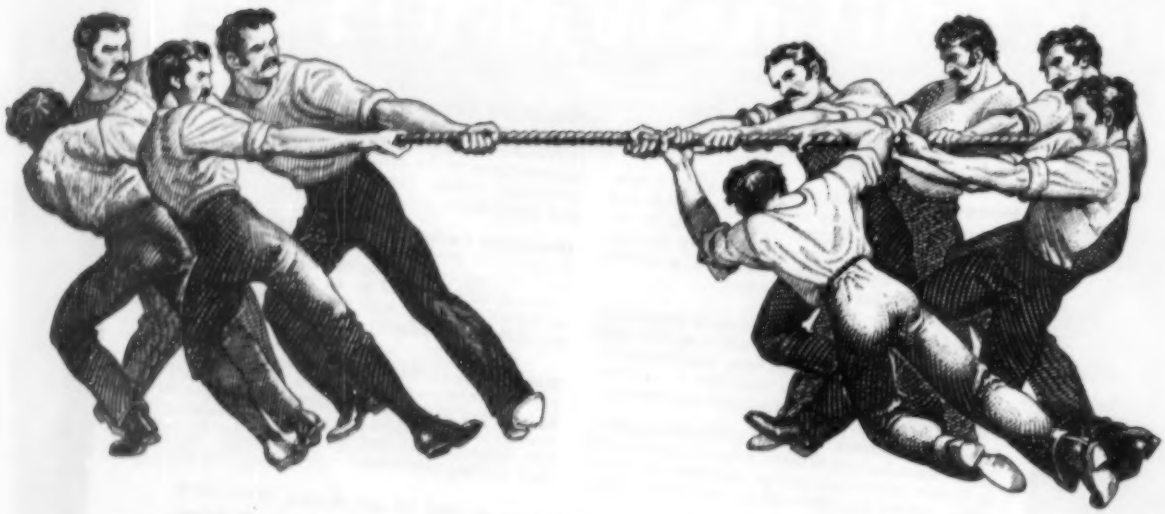
Jefferson
CHEMICAL COMPANY, INC.
260 MADISON AVENUE, NEW YORK 16, N.Y.

Branch Sales Offices: Chicago, Houston, Charlotte
West Coast Sales Agent: Hodson A. Howard Jr., Los Angeles
Plant: Port Neches, Texas
Other Stock Points: Chicago, Houston, Charlotte; Port Reading and Tenafly, New Jersey

For more data on advertised products, use Readers' Service Cards, last page.

boost production
with the Ljungstrom® Air Preheater

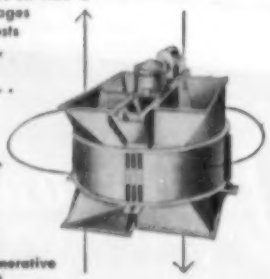
4 *of your units*
can do
the
work of 5



HOW FAST IS "WRITE OFF"?

In most cases, the Ljungstrom installation is quickly written off by increased capacity alone. Write-off time is even less when the other Ljungstrom advantages are considered — saves up to 20% of fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in fuel burning equipment — call or write The Air Preheater Corporation.



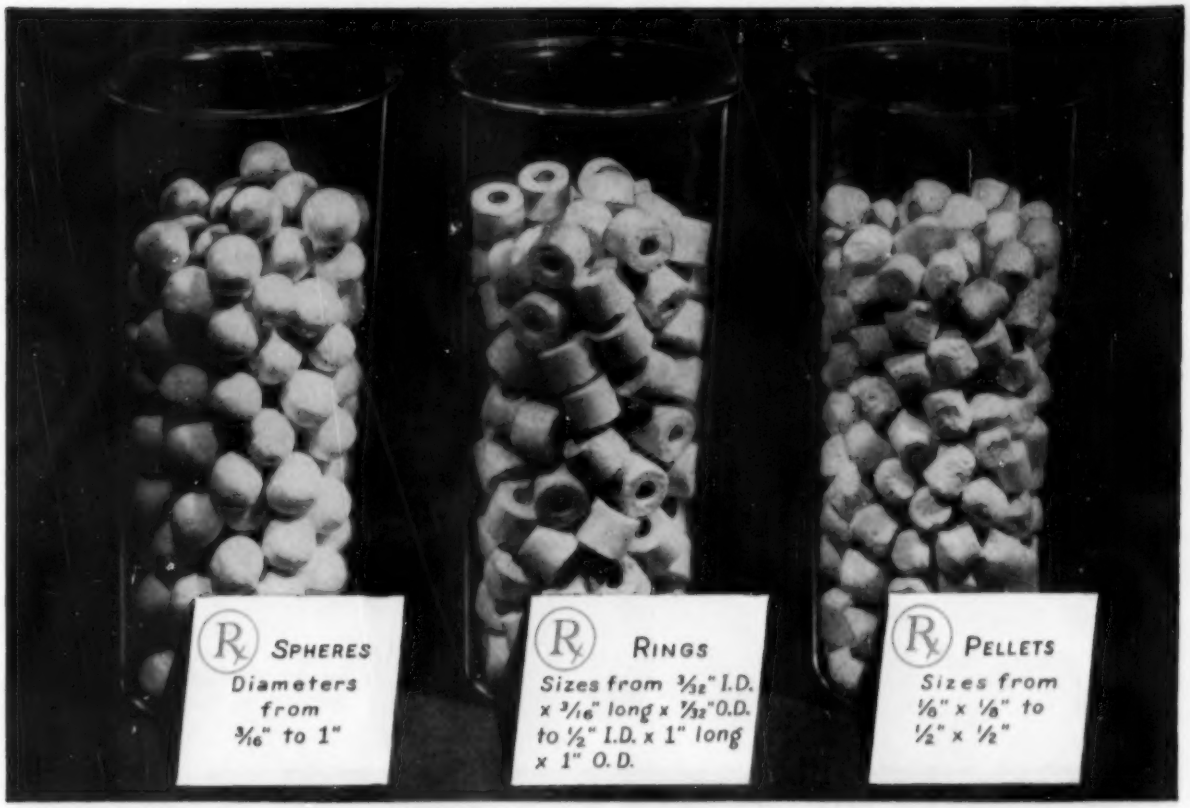
Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

Recover waste heat, return it to the furnace as combustion air, and you naturally generate higher flame temperatures . . . increase heat-transfer rates — *which means more through-put.*

That's why four of your present processing units can do the work of five *with Ljungstrom Air Preheaters increasing each unit's output as much as 25%.* One eastern refinery increased the continuous capacity of a pipe still from 16,000 to 18,000/20,000 barrels a day — by modernizing and including a Ljungstrom.

The Air Preheater Corporation **60 East 42nd Street, New York 17, N. Y.**


℞ SPHERES
Diameters from 3/16" to 1"
℞ RINGS
Sizes from 3/32" I.D. x 3/16" long x 3/32" O.D. to 1/2" I.D. x 1" long x 1" O.D.
℞ PELLETS
Sizes from 1/8" x 1/8" to 1/2" x 1/2"

What are your catalyst carrier applications?

Norton engineered and prescribed carriers offer you important processing advantages

What do you need? An inert, high alumina carrier for fixed bed oxidation reactions — such as those involved in the manufacture of phthalic anhydride, maleic anhydride and ethylene oxide?

An inert, low density carrier for use as a space filler or tower packing?

Norton ALUNDUM* fused alpha alumina carriers are proving highly successful in such processes. Containing 77% to 89% alumina, they are outstanding for chemical stability and resistance to abrasion and erosion — and their low density is a valuable quality in packing and filling applications.

ALUNDUM carriers are commercially available in the form of spheres, rings and pellets. Also available in experimental quantities are carriers made of MAGNORITE*, CRYSTOLON*, Fused Stabilized Zirconia and Kyanite materials.

ALUNDUM Spherical Carriers provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres (40%-44%) have a network of open pores on the outside surface only. These are specifically recommended for applications where the carrier is coated with a catalyst. High porosity spheres (45%-49%) have an internal as well as external network of pores, and are suitable for applications where the carrier is impregnated with a catalyst.

Other Norton Refractories for chemical processing include porous mediums, laboratory ware, ALUNDUM, MAGNORITE, CRYSTOLON, and Fused Stabilized Zirconia shapes. All are *engineered and prescribed* to give you the best possible ℞ — the most effective combination of physical characteristics plus thermal, chemical and electrical properties. For details call in your Norton Refractories Engineer, or write, mentioning your specific requirements to NORTON COMPANY, 465 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

NORTON
REFRACTORIES
Engineered... ℞ ...Prescribed

Making better products... to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

For more data on advertised products, use Readers' Service Cards, last page.

Performance-- Value...

FIG. 1561—150-Pound Steel Swing Check Valve.

FIG. 3003 FE—Steel Gate Valve For 300 Pounds W.S.P.

. . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . .

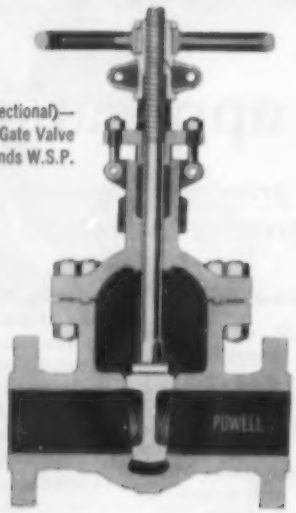


FIG. 6003 SS (Sectional)—Alloy Steel Gate Valve For 600 Pounds W.S.P.

Powell Valves

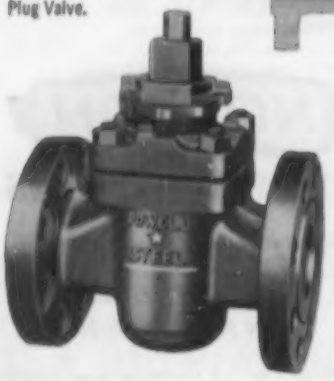


FIG. 1559—150-Pound Steel Lubricated Plug Valve.

You can depend on outstanding *performance* from every valve made by The Wm. Powell Company, for Powell Valves have a proven record of long life and dependable service.

And Powell Valves give you better *value!* They're precision made and incorporate many quality features—features that can save you money and give you lasting flow control.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our *COMPLETE quality line*, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

for lean oil feed at AMBROSE GASOLINE PLANT...

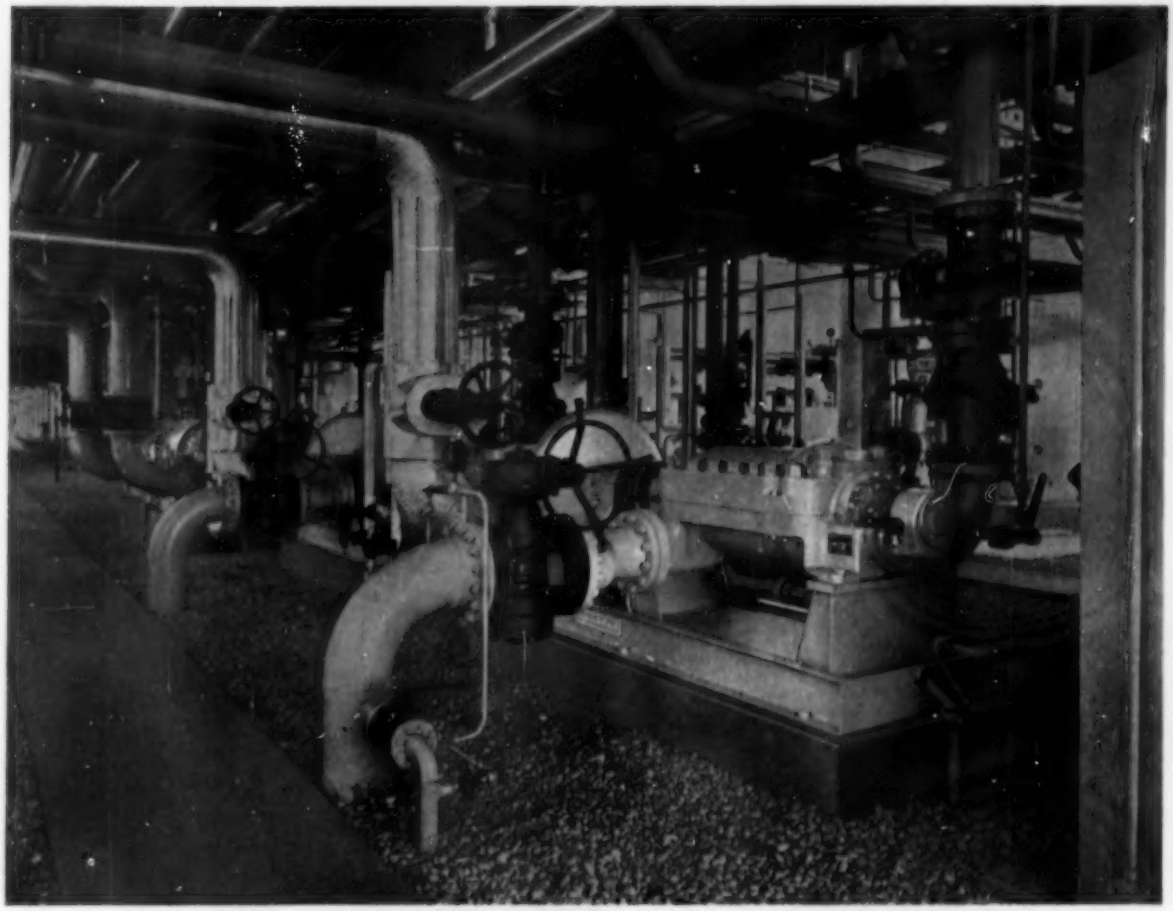


Photo by E. M. Payne

Ingersoll-Rand HMTA Pumps were chosen by Cities Service Oil Company. Three turbine-driven 5-stage pumps, with the I-R Unit-Type rotor assembly, serve the two absorption towers at this Blackwell, Oklahoma plant, designed and built by Hudson Engineering Corp. Present conditions call for 1650 gpm of 0.795 sp. gr. lean oil at 610 psig, but the ultimate designed production rate will require a lean oil pressure of 810 psig. The additional head will be developed by operating the pumps at increased speed. Perfect radial balance at both conditions of operation is assured by the multiple-volute fluid passage design of these HMTA pumps.

Other Ingersoll-Rand pumps at this new plant are on tower reflux, loading, still reflux, boiler feed and water circulation services. Three Ingersoll-Rand 8-cylinder gas engines supply the plant's electric power.

Your liquid moving requirements can be best met from the complete Ingersoll-Rand process pump line. Your nearest I-R office will be glad to study your needs and recommend the right pumps for your job.

Ingersoll-Rand

Cameron Pump Division
11 Broadway, New York 4, N. Y.

10-11

PUMPS • COMPRESSORS • TURBO-BLOWERS • VACUUM EQUIPMENT • AIR & ELECTRIC TOOLS • GAS & DIESEL ENGINES

Another amazing case history

WITH *Nalco*

CORROSION AND FOULING

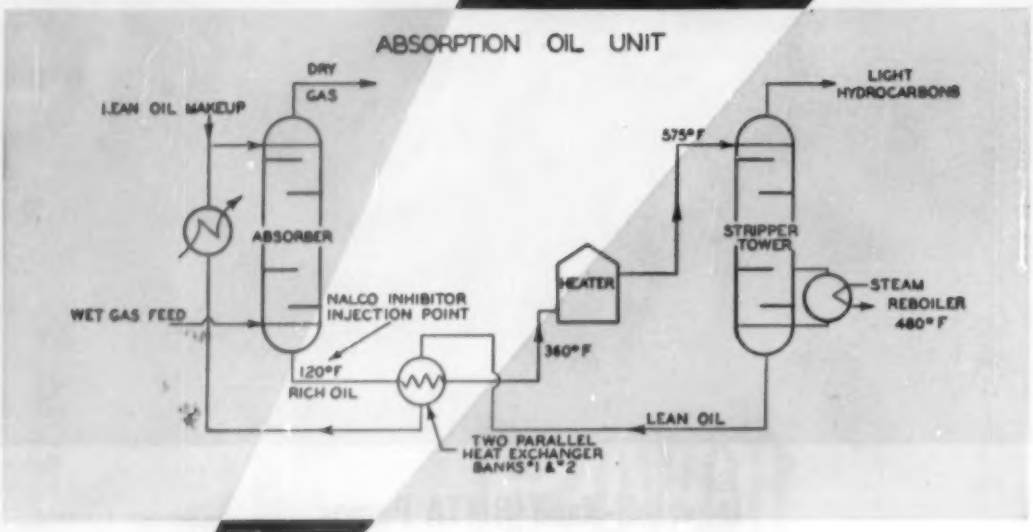
INHIBITORS

THE PROBLEM:

Severe fouling of heat exchangers in a cat cracker absorption oil system where temperatures range up to 575° F.

THE TREATMENT:

Nalco Inhibitor added at 20 parts per million to the absorption oil in the system.



THE RESULT:

Pressure drop across exchanger banks reduced from an average of 95 psi to an average of 12 psi by the detergent-dispersant action of Nalco Inhibitor. And for the first time in plant history, the exchanger banks required no manual cleaning after months of operation.

There's more to the story, too—because Nalco Inhibitors were then tried in another absorption system, and performed so successfully they are now used at a number of other locations within the refinery. If yours is a similar problem of fouling, corrosion or hydrogen blistering, it will certainly pay you to look into these amazing Nalco Inhibitors. Talk it over with your Nalco Representative or write direct.

NATIONAL ALUMINATE CORPORATION

6259 West 66th Place • Chicago 38, Illinois

In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco*®

SYSTEM . . . Serving Industry through Practical Applied Science

AN IMPORTANT MESSAGE CONCERNING...

A Basic Advance In Motor Insulation

ELECTRIC motor and generator insulation has come in for its share of announcements of "new" and "revolutionary" developments. But in spite of these announcements, inherent shortcomings of conventional insulation have remained.

There has been little basic improvement in motor insulating systems . . . UNTIL NOW.

Allis-Chalmers, working with engineers and scientists of Dow Corning Corporation, has developed *Silco-Flex* motor insulation . . . truly new in concept . . . truly new in effectiveness.

The *Silco-Flex* insulation system employs a pure silicone rubber combined with specially developed application techniques to produce an insulation unmatched by any other in use today. Outstanding improvements are shown in all these important characteristics:

Homogeneity — The complete *Silco-Flex* coil insulation is vulcanized into a single piece with no joints, voids or splices which can develop into breaks in the insulation. Even the best of the new conventional insulations combine several dissimilar materials which are held together by binders.

Heat Resistance — The excellent dielectric and mechanical properties in silicone rubber do not change significantly with aging at high temperatures over long periods of time.

Moisture Resistance — Completely sealed, *Silco-Flex* insulated coils are the most moisture-resistant coils ever produced.

Chemical Inertness — *Silco-Flex* insulation has outstanding resistance to most atmospheric contaminants, corona and weathering. It also withstands weak acids, alkalies and lubricants.

Flexibility and Resilience — *Silco-Flex* insulation remains flexible and resilient indefinitely under operating conditions. It is especially resistant to mechanical abuse and to the stresses brought about by overloading and rapid starting and stopping. It is also amazingly resistant to abrasion.

Heat Dissipation — Most electric insulators, unfortunately, are also heat insulators. *Silco-Flex* insulation, by comparison, is an excellent heat conductor and materially assists in removing heat from the coils.

What Are the Benefits?

The characteristics of this new insulation are so remarkable that complete reappraisal of motor application practices and motor performance is indicated.

In *all* applications, the chemical, mechanical and electrical properties of *Silco-Flex* insulation insure increased service reliability and longer life.

In addition, this new insulation system may reduce or eliminate the need for special motor enclosures. Atmospheres contaminated with cinders and fly ash, for instance, will have little effect on *Silco-Flex* insulated windings. Similarly, abrasive dusts in steel mills will not harm this insulation. Savings through the use of open, instead of totally-enclosed, frames will also be possible in chemical, paper, food and other industries where water or corrosive atmospheres are a problem.

What About Availability?

New *Silco-Flex* insulation is immediately available for all Class H form-wound coils and for Class A and B windings. operating under selected service conditions.

For complete information on SILCO-FLEX insulated motors, see your Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4664

Silco-Flex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

For more data on advertised products, use Readers' Service Cards, last page.

NOW! An Entirely New Method For Sizing Controls!

BS&B's New, Exclusive Method Takes Both The GUESS And The WORK Out Of Controls Sizing For Liquid, Steam And Gas Applications!

Today's modern and complex processing systems require accurate control valve sizing. No one has recognized this fact more than BS&B.

Therefore, as a service to industry, BS&B set out to develop a new, simple, more accurate method of sizing controls. Here it is in the new BS&B Controls Sizing Manual.

This new, exclusive method uses two new "tools" to make sizing more accurate—the SIZE-O-GRAPH to determine what the valve MUST do and Cv RATINGS to determine what the valve WILL do.

These "tools" are based upon thousands of hydraulic flow tests performed on all sizes and types of BS&B Controls in the industry's largest and most modern flow testing laboratory. Results are proven by correlation with *actual* gas and steam flow tests.

If you'd like a copy of this new manual, write to . . .

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-F6
7500 East 12th Street, Kansas City 26, Missouri

Get Both
bearing features

The bearing is enclosed with a bearing cap held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

fully enclosed and protected

. . . yet easy to grease

You can lubricate the bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at three points provide both means for inserting new grease and a means of flushing out old grease.

Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7286.

A-4610

ALLIS-CHALMERS

THE BIGGEST

Announcing

THE LQ600 VALVE

ANOTHER LUNKENHEIMER "FIRST"
. . . the revolutionary new bronze valve which has broken all existing performance records!

LUNKENHEIMER THANKS ALL OF THE LEADING COMPANIES WHO COOPERATED IN THE FOUR-YEAR LQ600 FIELD TESTING PROGRAM

The LQ600 Valve has been tested for four years in carefully chosen "problem installations" in American industry. *Despite the poor records of previous valves, there was not one single reported case of failure or leakage of an LQ600 Valve!* Here are a few typical records:

LUNKEN

THE ONE *Great*

BRONZE VALVE NEWS IN 50 YEARS!

This revolutionary bronze globe valve has set completely new performance standards in the most severe service in industry!

LQ600 gives you so much *more* service per dollar that you can't afford to continue using bronze globe valves that require constant repair and replacement!

Valve users, cooperating in a four-year testing program, were unable to find *any* service tough enough to wear out an LQ600 — or cause it to leak, even in the most severe throttling installations! This new valve is an investment — one that pays cash dividends in maintenance savings year after year!

BRINALLOY* SEATS AND DISCS make these remarkable performance records possible. This exclusive new Lunkenheimer alloy is far more resistant to wear and corrosion than 500 Brinell Stainless Steel — even outwears case hardened Stainless Steel exceeding 1000 Brinell! There is no need for renewability. *No LQ600 Valve in four years service has required maintenance.*

OTHER FEATURES — a streamlined new exterior . . . the famous Stemalloy® Stem, which far outlasts any other stem material . . . the cool, easy-to-grip Non-Slip® patented handwheel . . . durable, high-strength bronze in body and bonnet . . . and true back-seating, permitting safe and easy repacking under pressure.

*Patented alloy. Trade Mark, The Lunkenheimer Co.

For more information, call your local Lunkenheimer Distributor or write The Lunkenheimer Company, Box 360, Cincinnati 14, Ohio.

TYPE OF SERVICE	LIFE OF OTHER VALVES	USER COMMENT
125 lb. hose steaming	2 wks. to 2 mos.	Toughest service, previous valves leaked.
Water col. blowdown	2 mos.	Plug valves couldn't take it.
185 lb. steam blowdown	1 yr.	Plug valves failed every year.
125 lb. steam blowdown	"Short"	Previous valve leaked every run.
200 lb. steam—water col. blowdown	2 mos.	Previous valves failed by wiredrawing.
Throttling syrup 140°F.	"Short"	Previous valves cut.
150 lb. throttling 380°F.	6 mos.	Plug valves failed regularly.
100 lb. throttling	2 wks. to several mos.	Plug valves couldn't hold up.
130 lb. throttling	8 mos.	Composition seat valves unsatisfactory.
110 lb. throttling steam	3 wks. to 3 mos.	Three other kinds failed.
Scaled hot water line	"Short"	About all makes used—none held up.
125 lb. throttling steam	6 to 12 mos.	Plug valves failed by wiredrawing.
150 lb. steam—scale present	"Short"	Previous valves broke.
150 lb. throttling steam	4 to 5 mos.	Other makes failed by wiredrawing.

LQ600
150 LB. S.P.
300 LB. W.O.G.

HEIMER®

BRONZE • IRON
STEEL • PVC

NAME IN VALVES

L-455-4

For more data on advertised products, use Readers' Service Cards, last page.

he knows how to take the Debbil out of the Sun!

Old Sol—Devil or Saint can be . . . but to the farmer or rancher who has proper irrigation, the Sun is all Saint.

Layne knows a great deal about irrigation in all its phases because Layne knows a great deal about water, including development of ground water resources . . . utilization of existing water sources . . . application as well as proper equipment designed to meet specific conditions. Layne service to industry, agriculture and municipality has made Layne the world's largest developer of ground water resources—and that fund of knowledge is yours without cost or obligation when you "ask the man from Layne."

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Memphis 8, Tennessee

Layne Associate Companies Throughout the World

water wells • vertical turbine pumps • water treatment

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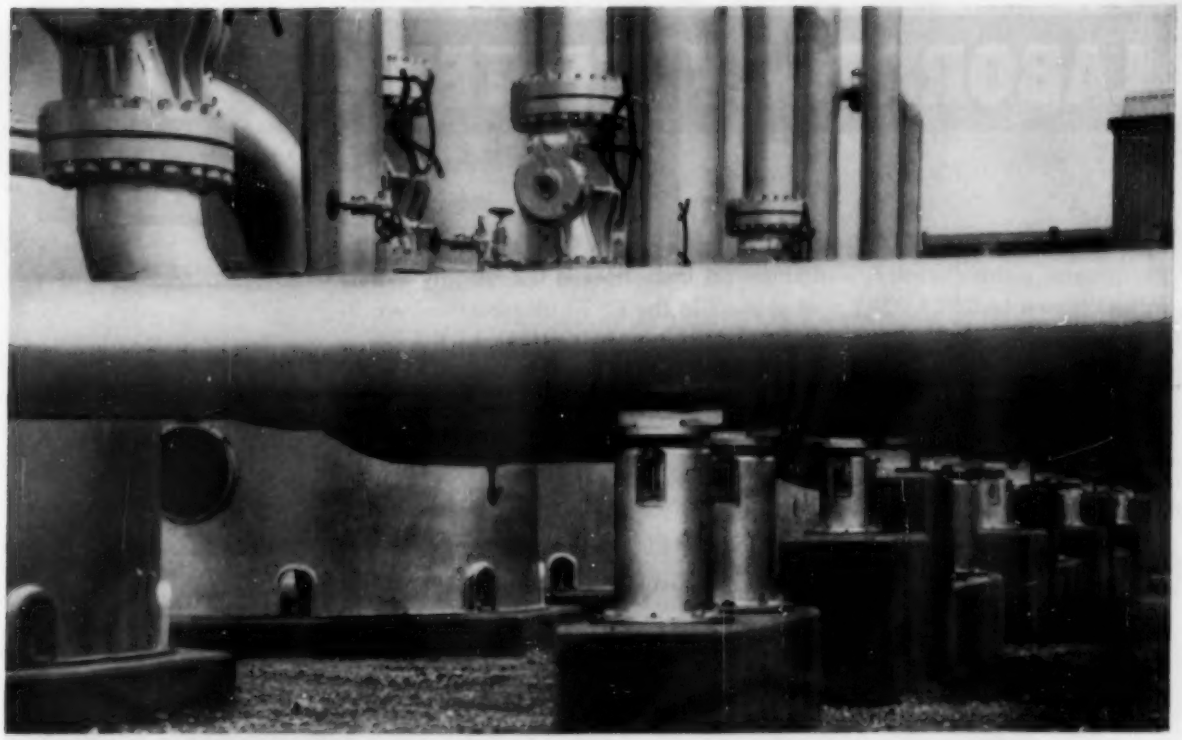
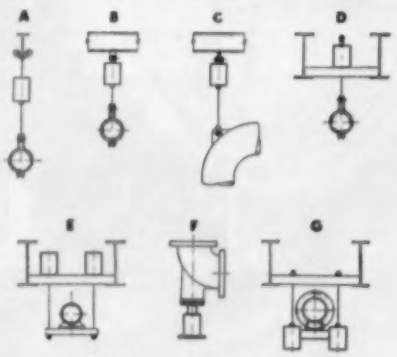


For *flexible* support of piping

Grinnell Pre-Engineered Spring Hangers

AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS



(Type A) Rod threaded to top cap (Type B) Furnished with single lug (Type C) Two lug style (Type D) Top adjusting (Type E) Adjustable top and bottom (Type F) For base support (Type G) Trapeze assembly.

The Grinnell Pre-Engineered Spring Hanger was developed after years of experience in analyzing the problems of flexible pipe suspension systems. It is *pre-engineered* to minimize changes in supporting force over total range of movement. Consider these outstanding features:

- **Maximum variation in supporting force per ½" of deflection is 10½% of *rated capacity* — in all sizes.**
- **Precompression* assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.**
- **Solid steel casing protects spring from damage and weather. Guides assure continuous alignment and concentric loading of spring.**
- **18 sizes available from stock for load ranges from 53 lbs. to 12,000 lbs.**
- **Available in 3 spring lengths for travel ranges of 1¼, 2½, and 5 inches.**
- **Installation is simplified by integral load scale and travel indicators.**

*Precompression is a patented feature.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

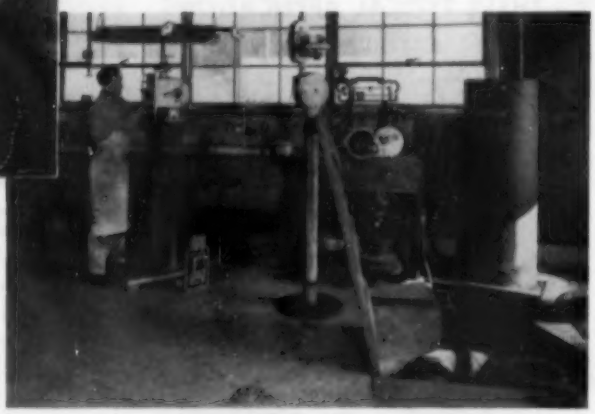
For more data on advertised products, use Readers' Service Cards, last page.

LABORATORY TESTED—Field Proved

SHAND & JURS EQUIPMENT designed and manufactured for the petroleum, petro-chemical and chemical industries is thoroughly tested in S&J's own LABORATORY and proved in the FIELD under actual working conditions. The S&J engineering department has the most modern testing facilities available right in their own plant where every S&J design is exhaustively tested. Through cooperation with major oil company engineering departments, S&J equipment is also thoroughly field tested, before being placed on the market. This provides a double check that S&J equipment will perform as specified before it is put into production for supply to the industries S&J serves.

At the right is shown the Hydraulic Testing Section of the S&J laboratory. Here fluid handling equipment is tested for capacity to pass liquid and for head loss. The machine on the bench at the left of the picture is a high pressure hydraulic cycling device.

At the left is a section of the S&J laboratory with test tank and flow measuring apparatus for breathers, flame arrestors, vacuum and pressure relieving devices. The tank is built in strict conformity to API specifications.



At the right is shown the Automatic Tank Gaging section with a 25 foot gage-float testing well. Also included in the S&J laboratory is a chemistry section for corrosion studies and control, and for accelerated testing to simulate field conditions.

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WE TOOK THE "Bugs" OUT OF DESALTING EQUIPMENT

Custom built electrostatic units engineered by Howe-Baker have the "bugs" removed before each design leaves the drawing board. That's why refiners using Howe-Baker installations on four continents are getting trouble-free operation in treating over 1,800,000 barrels of crude oil per day.

SPECIALISTS IN PETROLEUM EMULSIONS

THE HOWE BAKER CORP.

ESPERSON BUILDING • HOUSTON 2, TEXAS

PHILADELPHIA "HI-SPEED" SPEED REDUCERS AND INCREASERS

The new standardized Hi-Speed units contain all the features and advantages of "custom built" gear reducers. These rugged Philadelphia drives, available for both Industrial and Air Conditioning Service, are designed and manufactured specifically for the reducer or increaser application where rotating speeds range as high as 9000 RPM or pitch line velocities up to 10,000 feet per minute.

All rotating gears and shafts are dynamically balanced to provide the ultimate in vibration-free power transmission. Philadelphia Hi-Speed Units meet the modern trend toward higher prime-mover speeds of steam turbines, ultra high speed electric motors and internal combustion engines for driving compressors, pumps and mills through Speed Reduction Units. They are also used as *Speed Increasers* to drive high speed compressors, generators, pumps and fans.

DESIGN — in accordance with latest practices of the American Gear Manufacturers Association.

HORSEPOWER — from 1 HP to 7100 HP.

SPEED — to 9000 RPM and pitchline velocity of 10,000 fpm.

RATIOS — from 1:1 to 10:1 for either speed reduction or increase.

HOUSINGS — are quality gray cast iron of generous proportion, with heavy bearing bosses to provide rigid mounting for rotating parts.

GEARS — are double opposed helical type, designed to spread tooth load over three or more teeth. Thrust forces produced by helical gearing are completely balanced by opposed helical faces. Gear and pinion teeth are cut by hobbing process, finish-shaved to produce most accurate tooth contours. Gearing is dynamically balanced. Gears are manufactured from stress relieved alloy steel castings.

SHAFTS — are completely machined, with bearing surfaces hardened, ground, and polished.

BEARINGS — are babbitt lined, bronze backed precision type "sleeve" construction, which have become synonymous with high speed shaft rotation.

LUBRICATION — positive, force - feed, self - contained system, with spray nozzles to entire gear face at line of contact, and separate pressure lines to each bearing.

Send for Catalog HI and be convinced

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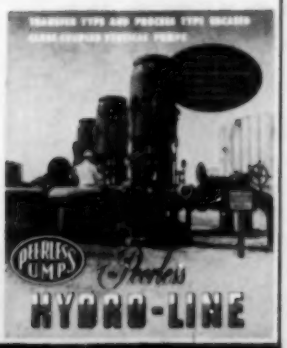
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA
Virginia Gear & Machine Corp., Lynchburg, Va.

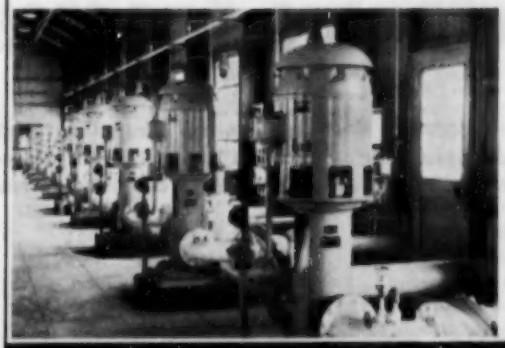
Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

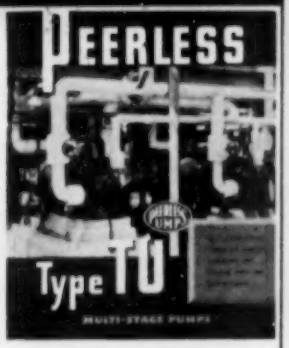
either way YOU LOOK AT THE PUMPING PROBLEM

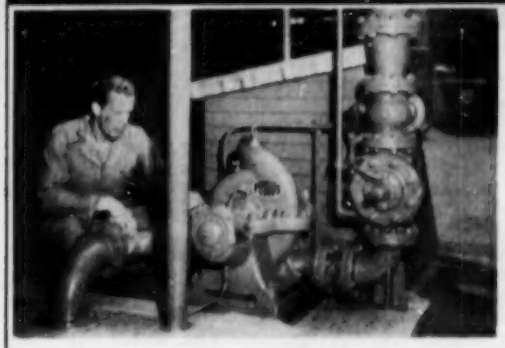




VERTICAL

Horizontal





PERFORMANCE-PROVED PEERLESS PUMPS WILL DO THE JOB BETTER

Here's why—You can choose from either Peerless vertical or Peerless horizontal designs for most every liquid transfer job—water or process liquids. You can select the pump you need from the broadest range of heads, capacities and horsepowers.

You can buy and apply a Peerless pump with the confidence that it will provide dependability over the years.

Bulletin B-1700, at the top above, describes Peerless vertical can type process pumps. Bulletin B-1400 just above describes multi-stage horizontal pumps for high pressure liquid transfer.

Write for your copies. You'll find out how Peerless pumps can squarely meet your pumping needs with economy, efficiency and dependability.

PEERLESS PUMPS

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FOOD MACHINERY AND CHEMICAL CORPORATION

Factories: Los Angeles 31, Calif., and Indianapolis 8, Ind.

Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis, Ind.; Phoenix; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque, New Mexico.

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Operation of Plant-Scale Installations* DEMONSTRATES BENEFITS OF ELECTRONIC PROCESS CONTROL

'American-Microsen' Electronic Process Control Installations Now In Successful Operation Have Proved The Reliability, Speed, Sensitivity And Accuracy Of This Modern Concept Of Process Instrumentation.

This is the electronic process control system that now makes it practicable to utilize the capabilities of process equipment far more fully than ever before. Revealed in actual operation of plant-scale installations are the much discussed benefits of this new approach to plant instrumentation.

Used to *measure, indicate, record and control process variables* (pressure, differential pressure, temperature, level flow, pH, gas analysis, etc.), these installations exhibit every essential to improve product quality, increase operational efficiency and plant productivity.

Only the 'American-Microsen' System provides:

Lag-free signal transmission using the simplest communication lines.

Extremely fast, accurate measurements and control responses — sensitivity impossible to duplicate in other types.

Installation of all controllers in the instrument room *any distance from the process* — even 30 miles or more.

High stability that permits use of narrower proportional bands.

Freedom from dirt, leakage, freeze-ups and other transmission line problems.

Standardized control components interchangeable at the panel and plug-in components on each instrument.

Adaptability — more than one input circuit can be fed into a controller for cascading or programming.

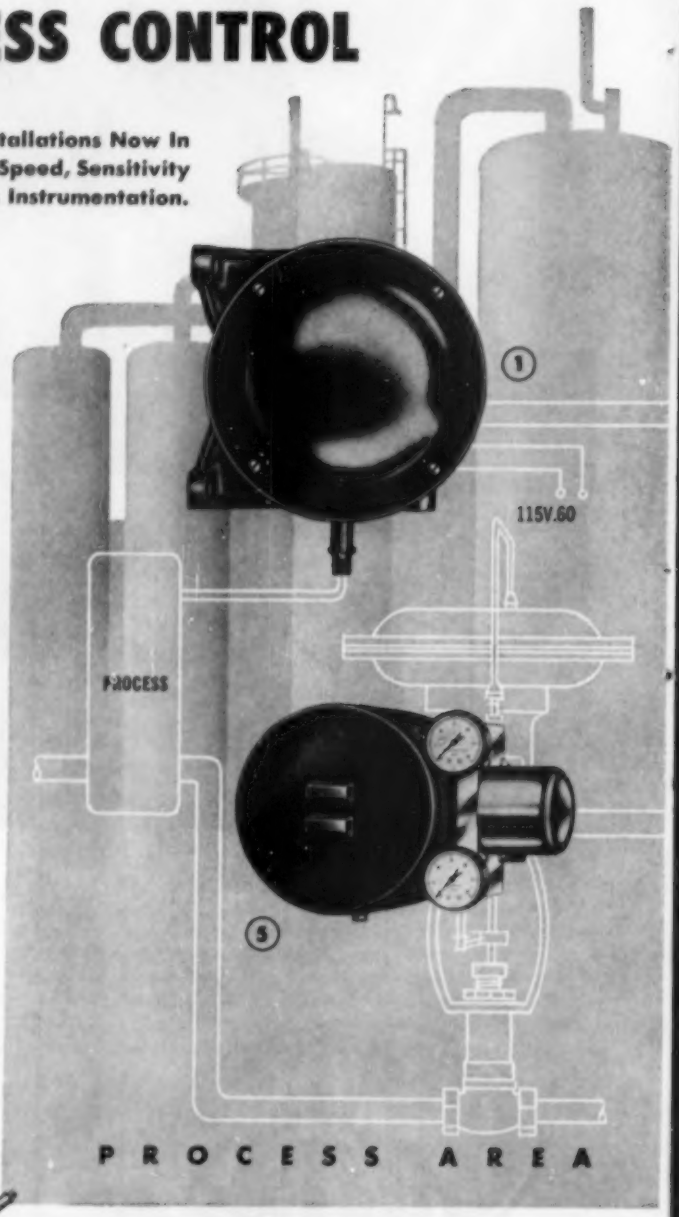
DC signal that can be fed to potentiometer recorders, digital read-out systems, monitors, computers, etc., so that process and operational data are automatically reduced to quickly usable form.

Flexibility — output signal can be fed in series to any number of receivers, without impairing accuracy. Components can be mounted anywhere convenient to operating and servicing.

Electrical circuitry makes possible unusual control and measurement functions not available in mechanical systems.

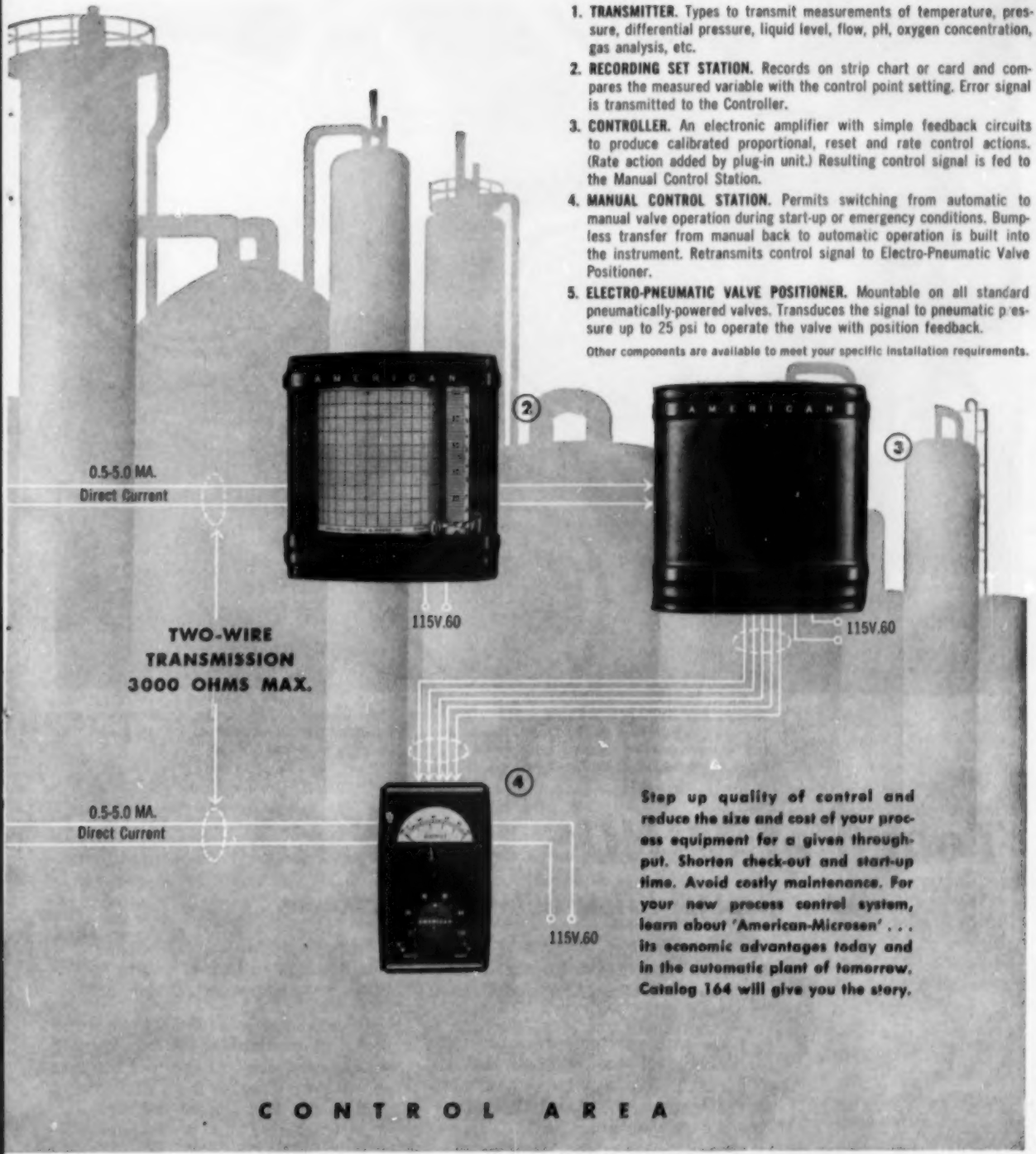
Minimum installation or maintenance investment in transmission lines, air compressors, filters, pressure regulators, dryers.

**Names and locations of installations available upon request.*



THE 'MICROSEN' BALANCE, the "nerve center" of 'American-Microsen' instruments, is a simple, electro-mechanical servo-mechanism. It operates on the force-balance principle to produce a high-level direct current signal that is not affected by any normal electrical or ambient condition.

MANNING,



1. **TRANSMITTER.** Types to transmit measurements of temperature, pressure, differential pressure, liquid level, flow, pH, oxygen concentration, gas analysis, etc.
2. **RECORDING SET STATION.** Records on strip chart or card and compares the measured variable with the control point setting. Error signal is transmitted to the Controller.
3. **CONTROLLER.** An electronic amplifier with simple feedback circuits to produce calibrated proportional, reset and rate control actions. (Rate action added by plug-in unit.) Resulting control signal is fed to the Manual Control Station.
4. **MANUAL CONTROL STATION.** Permits switching from automatic to manual valve operation during start-up or emergency conditions. Bumpless transfer from manual back to automatic operation is built into the instrument. Retransmits control signal to Electro-Pneumatic Valve Positioner.
5. **ELECTRO-PNEUMATIC VALVE POSITIONER.** Mountable on all standard pneumatically-powered valves. Transduces the signal to pneumatic pressure up to 25 psi to operate the valve with position feedback.

Other components are available to meet your specific installation requirements.

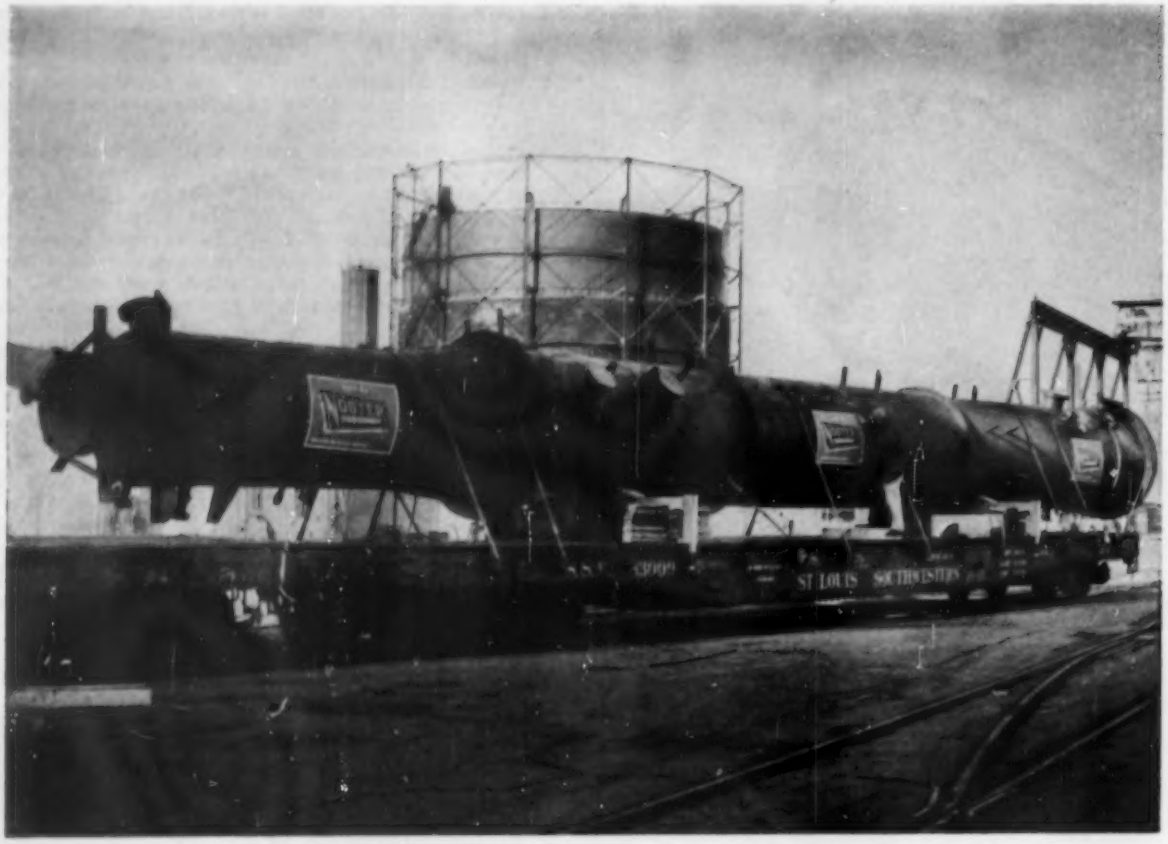
Step up quality of control and reduce the size and cost of your process equipment for a given throughput. Shorten check-out and start-up time. Avoid costly maintenance. For your new process control system, learn about 'American-Microsen' . . . its economic advantages today and in the automatic plant of tomorrow. Catalog 164 will give you the story.

MAXWELL & MOORE
INCORPORATED

INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC TRANSMITTERS, INDICATING OR RECORDING SET STATIONS, CONTROLLERS, MANUAL CONTROL STATIONS AND ELECTRO-PNEUMATIC VALVE POSITIONERS.



Ready for transit is a tower fabricated by Nooter Corporation, of St. Louis, Mo. Utilizing approximately 90,000 pounds of 1⅜" thick 3½% nickel steel plate to meet A.S.T.M. specification A-203 Grade D, this tower was built for the petrochemical industry and will operate at minus 140°F.

Tough at MINUS 140° F

...a nickel steel for safety at low temperatures

THIS FRACTIONATING TOWER is built of a steel that resists embrittlement at *minus* 140°F.

Even at lower temperatures, users find this steel strong, tough, safe. In contrast, carbon steels and many alloy steels become embrittled at temperatures no lower than –50°F.

And another important fact about this steel: *it's a standard grade ... low in carbon and containing 3½% nickel.*

Toughness, combined with good strength at sub-zero temperatures, is typical of low carbon steels containing nickel. In addition, you'll find they readily respond to fabricating operations, including welding.

From the many standard grades of nickel alloyed steels, you can usually select one which will give you the best set of properties to meet almost any fabrication and service demands.

Whatever your metal problem ... whether it involves low or high temperatures ... corrosion, wear, fatigue or other troublesome factors ... send details of your difficulty for our suggestions. Make use of our wide practical experience. Write us now.

INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

What it takes to make a 3000 Degree Refractory Concrete

Because of the widespread interest in the use of refractory castables, many furnace operators have asked us for the story behind the performance of B&W's unique refractory concrete, Kaocast.

Here are the answers to some of the most frequently asked questions:

Q. *When you refer to Kaocast as a 3000 degree refractory castable, do you mean that its melting point is 3000° F?*

A. No, this means that its service use limit is 3000° F; its melting point is 200 degrees higher.

Q. *Just what does it take to make a 3000 degree refractory castable like B&W Kaocast?*

A. Let's first define a few terms. Refractory castables are made with granular materials which are volume stable at high temperatures and which can undergo repeated heating and cooling cycles without disintegration. These materials, known as refractory calcines or grogs, are blended with suitable hydraulic binders. The initial strength of a refractory castable is thus developed in the same manner as that of ordinary concrete—that is, through the chemical action between water and the binder. A strong *ceramic bond* is formed when the refractory castable is subjected to temperatures above the vitrification point.

Q. *Then you have a grog, a binder and a method of putting them together. Which is most important?*

A. You can't say that any *one* is most important. It's a combination of all three. Let's take them one at a time. Our grog consists primarily of the proper blend of kaolin and other alumina-silica materials. This ratio enables us to achieve a grog with minimum expansion and shrinkage, a high fusion point, and greater stability under load, at varying temperatures.

Q. *And now, what about the binder?*

A. There are a number of factors responsible for the success of the Kaocast binder. One is the compound Tricalcium Penta-aluminate (3 lime to 5 alumina). This formula produces the most refractory compound (highest melting point) that can be made from lime and alumina. Another is that by using the purest commercially available lime and alumina, the Kaocast binder is substantially free of iron and silica. Such traces of these that are present combine during the pre-firing of the binder to produce stable compounds.

Q. *Just how important is the manufacturing or "blending" of the grog and the binder?*

A. If one factor could be singled out as "most important" it would be quality control.

Direct control over the fineness of materials, prefiring temperatures, and other phases of manufacture is possible at B&W because both the grog and the binder are made and blended at B&W's Augusta Works—under B&W's direct control and supervision.

Q. *These factors you've discussed must add up to some specific advantages of Kaocast. What are they?*

A. B&W Kaocast has all the advantages of easy installation which are responsible for the widespread interest in refractory concretes, plus these exclusive features: It is the only 3000 degree refractory concrete with high resistance to spalling and low volume change throughout its operating range.

THE BABCOCK & WILCOX CO.
Refractories Division
General Offices:
161 East 42nd St., New York 17, N. Y.
Works: Augusta, Ga.

(Advertisement)

For more data on advertised products, use Readers' Service Cards, last page.

Three 125,000 #/HR STEAM GENERATORS *by* Vogt AT LION OIL COMPANY'S BARTON CHEMICAL PLANT

★ The new $30 million Lion Oil Company's Barton Chemical Plant at Luling, La. produces 300 tons daily of essential nitrogen fertilizer materials to boost crop yields and reduce unit production costs on the nation's farms.

PRINCIPAL DATA, EACH UNIT

125,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 725 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

Water cooled furnace.

Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built type and package unit type steam generators. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuel burned singly or in combination. Write for bulletins.

HENRY VOGT MACHINE CO. 75th Anniversary LOUISVILLE, KY.

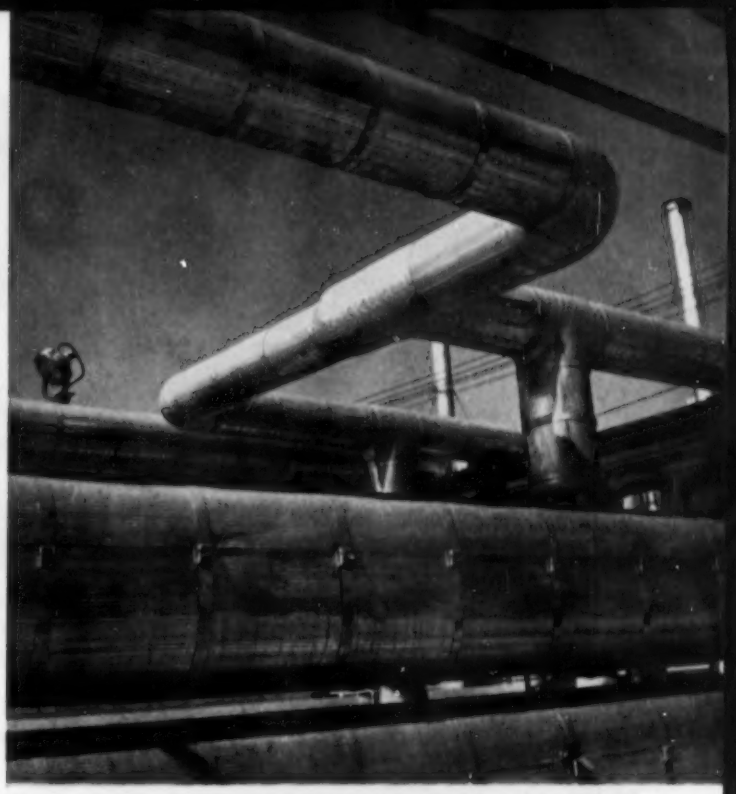
Henry Vogt Machine Co., Louisville, Ky.

BRANCH OFFICES:

New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va., San Francisco

How Olin Mathieson Uses Childers Jacketing For Insulated Lines

Jacketing problems at new plant ranged from covering tall towers to irregularly-shaped heat exchangers. Read how aluminum jacketing solved these problems.



More than 244,000 square feet of Childers .006" Jacketing and 35,000 square feet of heavy weight Childers Jacketing was used in this new Olin Mathieson plant to weatherproof insulated lines, towers and vessels. Close-up above shows how aluminum jacketing was applied with strapping and seals.

Low first-cost, long life, and easy installation were the big reasons Olin Mathieson Chemical Corporation used Childers Aluminum Jacketing for outdoor insulated lines in their new Brandenburg, Ky., petrochemical plant.

Mathieson used Childers standard weight Jacketing on their insulated lines. Heavier weights of Childers Jacketing were used on high towers and vessels where a stiffer material was needed to support the vertical weight of the jacketing.

Engineers report that Childers Jacketing is inexpensive to apply. It comes in easy-to-handle rolls 4 ft. wide and 100 ft. long. Just pliers and a pocketknife are the only tools needed to apply. And because the jacketing is aluminum it needs no painting . . . stays clean and new looking even after years of service.

Childers Jacketing is easily removable, too. Just remove the strapping and jacketing can be taken off for inspection of the lines. Then same jacketing can easily be put back on the insulated line.

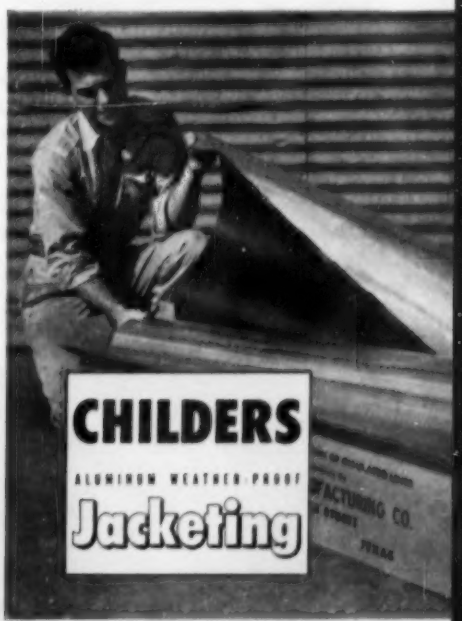
Immediate shipment from our large factory stocks can eliminate costly delays in construction or plant improvement schedules.

Try this low-cost protection in your plant. Write today for engineering data and information. You can order a 400 sq. ft. roll to test on one of your insulated lines. No obligation. Address: Childers Manufacturing Company, Department PR-26, 3620 West 11th St., Houston, Texas.

How to apply Childers Jacketing:

1. Best method of attaching jacketing is aluminum strapping and seals. Strapping can be pulled plenty tight with pliers like this. Other method is to use sheet metal screws.

2. A two-man crew can apply jacketing fastest. No special shop work or roll forming is necessary. Only tools needed are a pliers and a screw-driver or wooden wedge.



Each roll of Childers Jacketing comes individually packed like this in a heavy corrugated carton. Rolls are 4 ft. wide. With moisture barrier attached they are 100 ft. long; without moisture barrier they are 200 ft. long. They are well protected for field storage if kept dry. Individual boxes are light enough for one man to handle. (Adv.)

YORKMESH

DeMISTERS

Assure clean separation between vapor and liquid

Yorkmesh Demisters—by effecting clean separation between vapor and liquid—improve the performance and increase the throughput capacity of any process vessel handling both liquid and vapor phase materials.

Yorkmesh Demisters are knitted wire mesh pads, available in a variety of types, sizes and materials. The unique fine wire construction provides flexibility, resiliency, light weight, high structural strength and extensive surface area. These Demisters are supplied to the exact size and shape required and are usually furnished mounted on light weight open type support grids. Installation is simple in both new and existing equipment.

Vapor-liquid separation efficiency with Yorkmesh Demisters in process vessels is always very high, usually in excess of 99.9%. Where Yorkmesh Demisters are installed in evaporators, distillation columns, gas filters and absorbers, liquid entrainment is substantially completely eliminated.

Pressure drop is so low that it is nearly always negligible. At atmospheric pressure vapor velocities between 2 and 12 ft./sec. are recommended. Under vacuum, depending on conditions, vapor velocities of 30 ft./sec. and higher are possible.

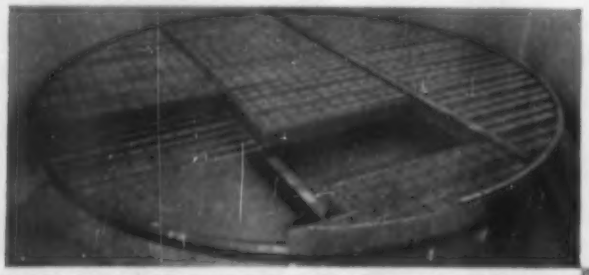
Yorkmesh Demisters are fabricated in a wide variety of materials, densities and wire mesh constructions which are selected to give best performance for the particular operating conditions.

Yorkmesh Demisters are available for prompt delivery in the following materials:

Types 304, 316, 317, 410 and 430 stainless steel
Monel, nickel, Inconel
Aluminum (56-S wire alloy)
Low carbon steel, copper, brass
Also available in Carpenter 20 stainless,
Hastelloy B & C, tantalum etc.

The wide experience of the Otto H. York Co., Inc. with thousands of demisters in service provides a sound basis for recommendations that assure the most economical and efficient type of demister for each application. Call on York to solve your problems in vapor-liquid separation.

Complete catalog and list of technical literature (TL54) free on request.



SECTIONAL CONSTRUCTION—recommended for large vessels and for all applications requiring installations through a manhole.

ONE-PIECE CONSTRUCTION—recommended when installation can be made through end of vessel.

Increase throughput capacity!
Improve process efficiency!
Improve overhead quality!
Reduce contamination!
Stop costly liquid loss!

Yorkmesh Demisters are being used successfully in all types of process vessels handling both liquid and vapor phase materials. Some typical examples—

VACUUM TOWERS:
To increase throughput and improve quality of gas oil by separating entrained asphalt. To decrease metals contamination of gas oil. To improve quality of lube distillates.

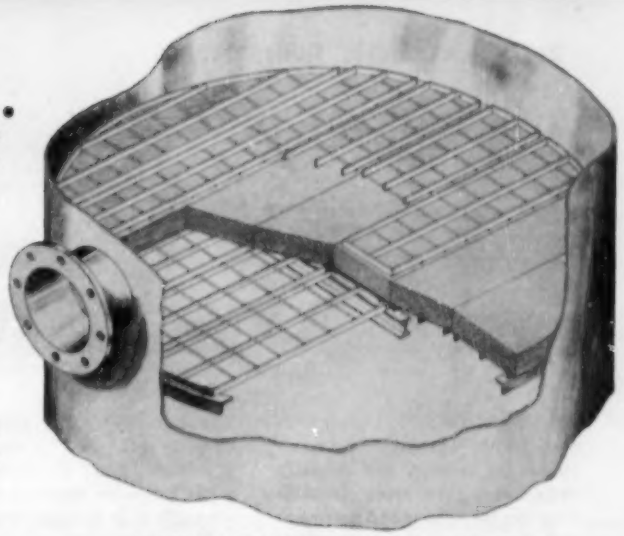
DISTILLATION:
To remove entrained liquid fatty acids from fatty acid vapors. To improve quality of organic product while increasing production. To eliminate glycerin losses.

FLASH TOWERS:
To recover clean naphtha from asphalt solutions. To separate propane from asphalt.

ABSORBERS:
To remove absorption oil from natural gas. To prevent loss of glycol and amine solutions.

EVAPORATORS:
To produce high purity steam from concentrated caustic soda solutions. To stop entrainment losses from valuable fluoride solution.

KNOCK-OUT DRUMS:
To remove water and oil from air. To remove fatty acids from superheated steam. To reduce compressor maintenance by removing liquid entrainment from the gas.



SECTIONAL TYPE DEMISTER IN PLACE—cutaway view.

STEAM DRUMS:
To eliminate liquid entrainment in order to produce high quality, high purity steam.

GAS FILTERS:
To clean manufactured gas. To separate sulfuric acid and solids from chlorine gas.

COMPRESSORS:
To separate entrained liquids from compressor discharge gasses.

SCRUBBERS:
To separate water from natural gas. To eliminate mist from flue gas. To remove natural gasoline from natural gas.

HOW TO GET THE BEST PERFORMANCE—
Send us details on type of process vessel or operation (absorber, vacuum tower, evaporator, knock-out drum, etc.); vapor flow rate, pressure, temperature, and density or molecular weight; liquid rate, viscosity, and specific gravity; for existing equipment advise dimensions, indicate vertical or horizontal vessel, and material of construction required. Furnish a drawing or sketch if possible. Complete details will enable us to make a precise recommendation and price quotation.

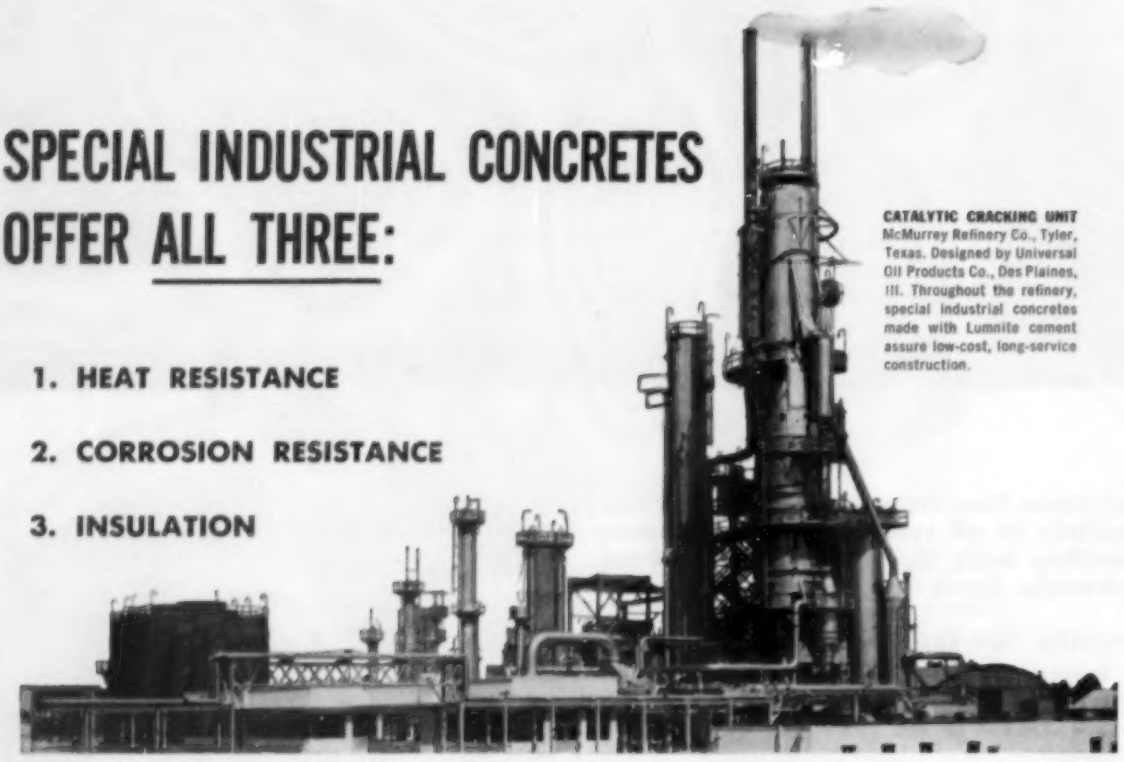
YORK

OTTO H. YORK CO., INC.
6 CENTRAL AVE. • WEST ORANGE, N. J.
"clean separation between vapor and liquid"

For more data on advertised products, use Readers' Service Cards, last page.

SPECIAL INDUSTRIAL CONCRETES OFFER ALL THREE:

1. HEAT RESISTANCE
2. CORROSION RESISTANCE
3. INSULATION



CATALYTIC CRACKING UNIT McMurrey Refinery Co., Tyler, Texas. Designed by Universal Oil Products Co., Des Plaines, Ill. Throughout the refinery, special industrial concretes made with Lumnite cement assure low-cost, long-service construction.

• Special industrial concretes made with Lumnite* calcium-aluminate cement are actually three-in-one concretes, because they can resist heat and corrosion and *insulate at the same time.* That means you can now use fast, economical industrial concrete in many ways throughout the refinery.

All these concretes are readily made to meet your specific problems of temperatures up to 2600°F. . . . corrosion . . . or special insulating needs.

Best of all, industrial concretes save you money, because construction time and production losses are kept to a minimum. Installation is quick – just trowel or pour into place, or shoot with a cement "gun." Concrete made with Lumnite reaches service strength in 24 hours or less.

For convenient maintenance you may prefer to use prepared castables (packaged mixes of Lumnite cement and selected aggregates for specific temperature and insulation needs – add only water). They're made and distributed by refractory manufacturers. For more information write Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York City 17, New York.

WHERE TO USE SPECIAL INDUSTRIAL CONCRETES

- Tank linings and pipe linings for protection from sour crude
- Linings of reactors; fractionating columns, cracking, distillation, vaporizing and alkylation units; stripper and flash towers; accumulators and soakers
- In furnaces, heaters and coking ovens
- In ducts and furnace foundations
- Stack and flue linings

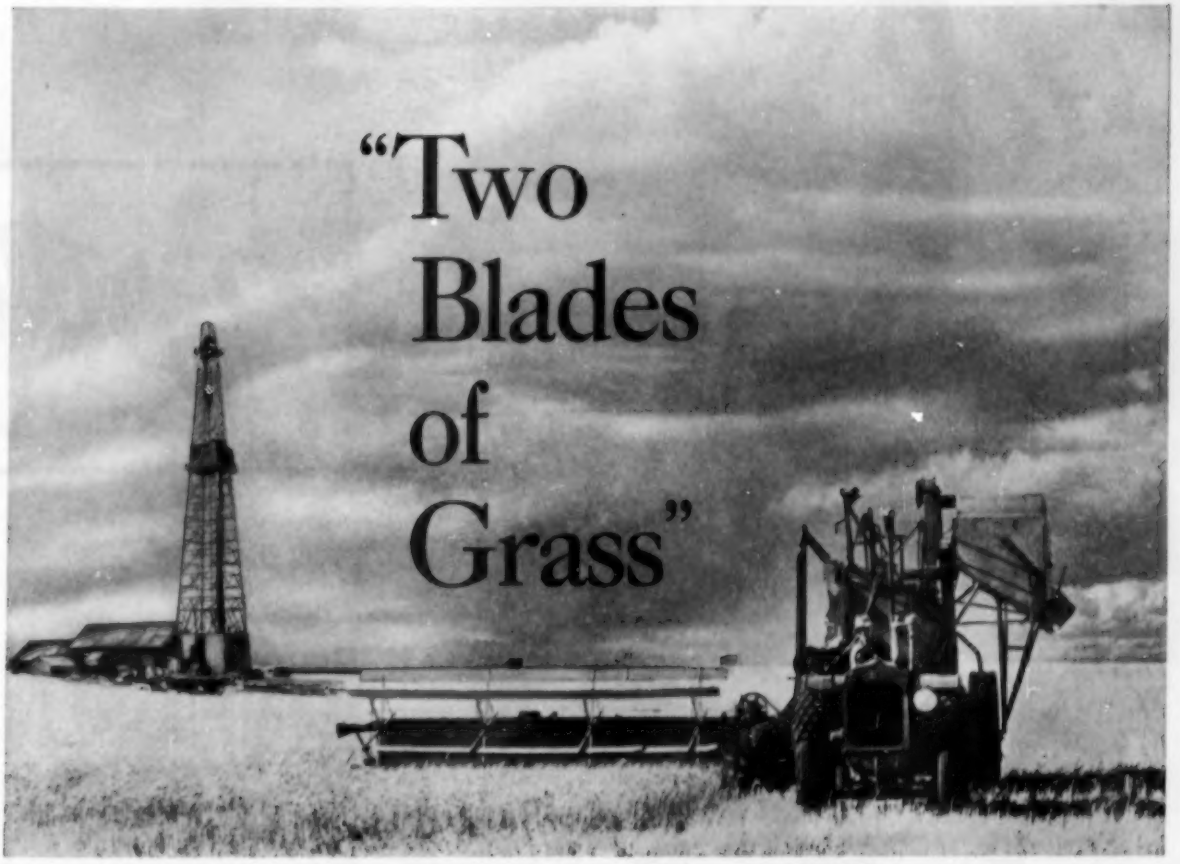
*"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

PR-L-55

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.



TWO CENTURIES ago Voltaire said, "He who makes two blades of grass grow in place of one renders a service to the State." The job of Standard Oil Company (New Jersey) and its affiliates is something like that – to produce oil where none was produced before and, by so doing, to create wealth for everybody.

How well have we been doing this job? Our Annual Report for 1954, which has just been sent to the 300,000 shareholders who own Jersey Standard, tells about it.

It tells how wealth was created by extending known oil fields . . . And by discovery of new ones . . . By converting crude oil, itself of little value, into hundreds of useful products . . . By moving petroleum products from where they were made to where they were needed.

All these things helped the people and strengthened the nations where we do business.

Some highlights of these activities, drawn from the Annual Report, are set forth here as a matter of public information.

1. During 1954, the free world used more oil than ever before. And oil is energy, which is basic to the world's progress.

2. To meet these needs, our affiliates produced and refined more oil than ever before in the Company's history. But additions to oil reserves were greater than the oil used.

3. We had vigorous competition everywhere. There is nothing like competition to bring you better products and service.

4. 1954 was our top year in sales, earnings, and dividends paid to owners.

5. During the year, we spent 764 million dollars for new equipment and for exploration. Since World War II, we have spent 5 billion dollars for the means to meet your future oil needs.

6. Research was productive. Our research affiliate obtained more patents on products and processes than any other oil company. In Linden, N. J., the first atomic laboratory in the oil industry is being built to study the uses of radiation in oil refining.

7. Current developments in atomic energy will mean greater availability of electric power: increased mechanization, expanded industry, and greater use of petroleum products. The oil business will gain, and you will have the benefits of both kinds of energy.

8. We played an important part in arranging to return Iran's oil to world markets.

9. A world's safety record for major refineries was set by Esso employees at Baton Rouge, La....7,911,769 man-hours with no disabling injury. This passed the previous record by more than a million man-hours.

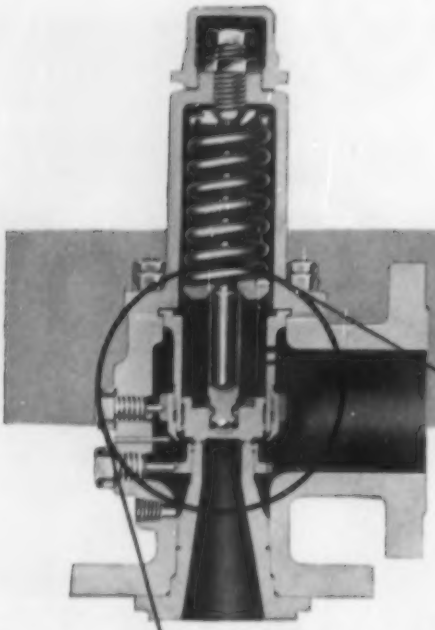
10. We have long supported education through our taxes. We have also felt an obligation to aid privately supported colleges and universities, which are an important source of new employees and of informed citizens. During 1954, we contributed about a million dollars to such institutions.

If you wish a copy of the full Report for 1954, write to Standard Oil Company (New Jersey), Room 1626, 30 Rockefeller Plaza, New York 20, N.Y.

STANDARD OIL COMPANY (NEW JERSEY)
AND AFFILIATED COMPANIES

Esso

For more data on advertised products, use Readers' Service Cards, last page.



CROSBY *Protecto*

Standard Full Nozzle
JO Relief Valve

Protecto-Seal Bellows
Design—interchange-
able with Standard
JO Relief Valve

EXCLUSIVE

BELLOWS PROTECTOR
(Pat. Applied for)

1. *Isolates and protects Bellows from turbulence caused by flowing media—reducing tendency of Bellows to fatigue.*
2. *Acts as positive lift-stop thereby preventing over compression of the Bellows.*

EXCLUSIVE

1. All moving parts are guided and held in perfect alignment from a single member.
2. The floating disc is loaded at the lowest point possible in the disc to provide the best in alignment stability and seat tightness.

FLOATING DISC

1. Simplifies maintenance.
2. Ease of dis-assembly.
3. Permits remachining.
4. Anti-fouling.

Seal Bellows Relief Valve

The addition of the Crosby Protecto-Seal Relief Valve to the well known line of Crosby JO Relief Valves marks a forward step in the design and construction of valves primarily for use on services where protection against corrosion, fouling of working parts, and low back pressure surges is required. The design represents the results of field tests conducted under the severest operating conditions.

The design of the valve is featured by the EXCLUSIVE Bellows Protector which shields the Bellows from adverse turbulent effects from the flowing media, preventing premature failure of the Bellows due to fatigue. The two ply bellows is so designed that the effective area of the valve seating surface is essentially balanced to nullify the effect of variable and constant back pressure on the performance of the valve. Now, with the Protecto-Seal Valve and the Balanced Area Piston Type Valve, Crosby offers relief valves for the widest range of back pressure conditions.

The Protecto-Seal construction is available in eleven orifice sizes and is interchangeable with the present line of Full Nozzle JO Relief Valves. Pressure-temperature scopes and dimensions remain the same as listed in the present 300 Catalogue. Valves available with internal heating coils and flushing nozzles on request.

Send operating data to Wrentham for recommendations.

Proven Performance

Designed, tested, and proved in our own steam and water test laboratories over a wide range of pressures. Performance checked on:

GAS—A.S.M.E. Test Facility
VAPORS—Wide range of temperature and Pressure
LIQUIDS and FLASHING FLUIDS—Private Laboratories and Power Plants of a leading Public Utility

This Valve has been tested for performance and flow at pressures from 25 p.s.i. to 2500 p.s.i.

CROSBY STEAM GAGE & VALVE COMPANY

FACTORY: WRENTHAM, MASSACHUSETTS

BOSTON • NEW YORK • CHICAGO • DALLAS • LOS ANGELES • LONDON • PARIS

For more data on advertised products, use Readers' Service Cards, last page.

stainless steels are thoroughbred, too

The experienced exhibitor rents extra stalls... leaves them empty... to prevent contamination of his thoroughbred pets by canine neighbors.

To develop their best qualities demands *exclusive* care. That is why Sun Ship's new Alloy Products Shop has been planned for the *exclusive* fabrication of stainless and alloy steel products. When you have selected from the many available Alloys a stainless steel best suited for your service condition, you have done only half the job. You must also provide for the best possible fabrication if you are to have full protection—"A Thoroughbred Job."

Why entrust stainless steel to be fabricated in the same shop where carbon steel products are fabricated, and subject this precious metal to contamination with iron fragments, dust, or other harmful elements? A segregated shop is your answer.

Sun Ship now operates an all-alloy shop, one especially built and equipped for fabricating stainless and alloy products as they should be—segregated from carbon steel fabrication.

We emphasize the fabrication of medium and heavy stainless, alloy and aluminum products for industry.

Try Sun Ship for stainless fabrication as it should be done.

Our Sales Engineering Department will be pleased to assist you with any of your fabrication problems.

Sun Ship also makes all types of carbon steel pressure vessels.

ALLOY PRODUCTS SHOP

OF Sun SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • CHESTER, PA. • 25 BROADWAY, NEW YORK CITY

This

NEW BULLETIN

provides economical solutions to every industrial water treatment problem

ENGINEERS and consultants helped prepare this new Bulletin No. 953 . . . "Controlled Volume Pumps for Water Treating Systems."

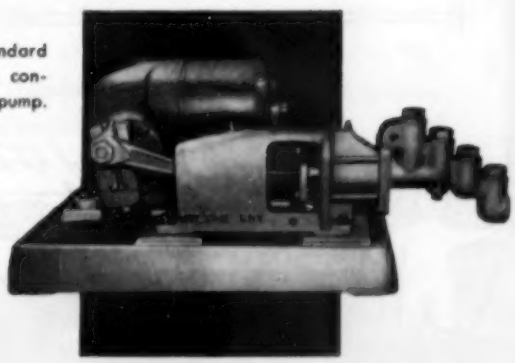
It has been termed, "a most important contribution to water treating literature."

Over fifty illustrations are used in this first-of-its-kind Bulletin, to describe and picture:

- Controlled Volume Pumps and how they work.
- Actual applications in all phases of industrial water treating.
- Basic and advanced system design.

Send for your free copy today . . . on your company letterhead, please!

For specific recommendations on water treatment problems, see your consulting specialist. For reliable, accurate flow control of water treating chemicals, see Milton Roy Company, Manufacturing Engineers, 1300 East Mermaid Lane, Philadelphia 18, Pa.



Milton Roy standard motor-driven controlled volume pump.

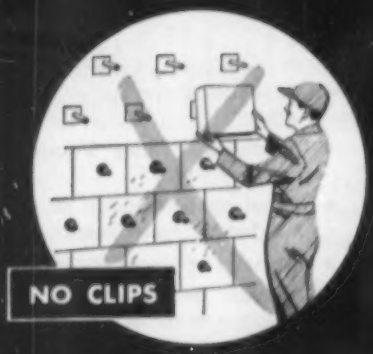
milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

For more data on advertised products, use Readers' Service Cards, last page.

POLY-CELL

. . . the Sprayable Foam Insulation



POLY-CELL, the Foam Insulation of individual tiny cell construction, is one of the most convenient forms of insulation ever developed.

It sprays like paint . . . it foams 20 times its original thickness . . . it can be installed without trouble anyplace where a spray gun can be pointed.

It forms a very tough, durable and effective insulation. No bands or clips are needed. It has the tenacity of glue even on vertical and inverted areas.

POLY-CELL makes possible a great reduction in application time. You can eliminate the tricky cutting of insulation and banish the trouble of fitting around particularly tough places.

For specifications and complete information, write for Bulletin No. P1.

Keep your Insulation Dry...

Your Vessels Free From Rust with Insul-Mastic #4010

For vaporsealing POLY-CELL or other insulations and for preventing corrosion of metal equipment and structures, always specify INSUL-MASTIC #4010 . . . industry's most durable bituminous coating.

Think first of the coatings that last!

Insul-Mastic

Representatives in Principal Cities

CORPORATION OF AMERICA • 7750 West 61st Place, Summit, Illinois

where intolerance is a virtue!

Intolerance of salt in crude charging stocks is one of the first rules of refining efficiency. Many refiners advantageously desalt crude oils containing as little as 20 pounds per thousand barrels. With certain refining processes the salt tolerance is much lower. In general, the trend of permissible salinity is constantly downward.

Tretolite desalting removal percentages average between 95 and 100%, with many instances of 99 plus per cent removals. In spite of this excellent performance, the chemical cost of Tretolite desalting averages approximately 2 mills per barrel.

For complete information, ask the Tretolite refinery service engineer in your area or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 MARSHALL AVENUE, ST. LOUIS 19, MISSOURI

5515 TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA

These advantages of Tretolite desalting insure maximum desalting performance at minimum cost.

1. **Low equipment cost**
2. **Simplicity of operation**
3. **Flexibility of operation**
4. **Efficient solids removal**
5. **Minimum operating attention**
6. **High percentage salt removal**
7. **Clean effluent water**
8. **Always available service**

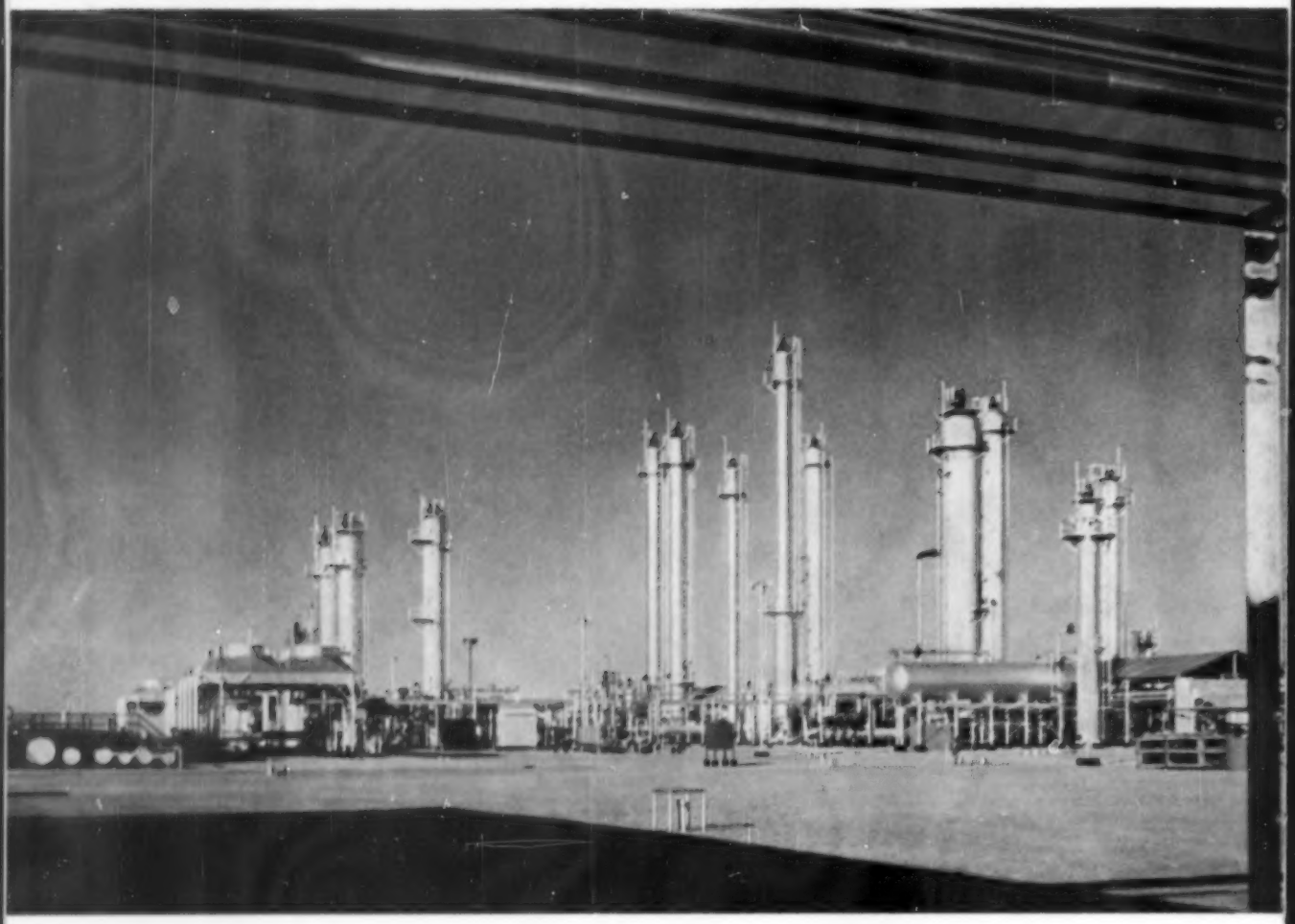
Chemicals and Services for the Petroleum Industry

DESALTING • CORROSION INHIBITING

DEMULSIFYING • SCALE PREVENTIVES

WATER DE-OILERS • ASPHALT ADDITIVES

TR 55-8



THE *Pegasus* GASOLINE PLANT

In the Pegasus field near Midland in West Texas HUDSON has completed the latest of SEVEN MAJOR PROJECTS for Magnolia Petroleum Company. These seven projects plus numerous smaller ones for the same client are typical of the work that has built the world-wide confidence of the oil industry in the ability of HUDSON to complete small or large processing plants in minimum time, with assured performance, and with minimum capital outlay consistent with low operating costs.

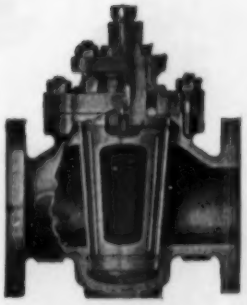
Repeat contracts with a long list of satisfied clients make up a large part of the more than 100 projects constructed by HUDSON in the last fifteen years.

DESIGNERS AND CONSTRUCTORS OF OIL AND GAS PROCESSING PLANTS

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

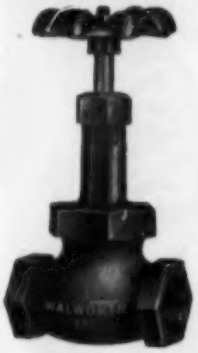
• VALVES
• PIPE FITTINGS



Walworth
Lubricated Plug Valve

Walworth
Steel Gate Valve

Walworth
Iron Body Gate Valve



Walworth
"500 Brinell" Bronze Globe Valve

Walworth
Iron Body Saddle Gate Valve

Walworth
Cast Steel Flanged Fittings

Walworth manufactures a *complete line* of valves and pipe fittings: all made to the highest standards of quality, both as to dimensional accuracy and metallurgical properties. In design, construction, and performance, Walworth products reflect more than a century of experience in the manufacture of quality valves and fittings.

Your Walworth distributor will give you full information on the *complete line* of Walworth steel, iron, and bronze, and special alloy valves and pipe fittings; also Walworth Lubricated Plug Valves, and Walseal* valves, fittings and flanges. Ask for this information today.

*Patented—Reg. U. S. Pat. Off.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

3:59.4 or 4:01.4

There's enough difference To make all the difference

A difference of only 2 seconds . . . but it made sports history on May 6, 1954, when the first under-four-minute mile was run in Oxford, England.

The differences in quality and performance that Scovill builds into its Heat Exchanger Tube, while they also may seem small, can make a *big* difference in improving your operating record. Scovill Phosphorized Admiralty Heat Exchanger Tube, for example, begins its long service life with an added advantage. It is initially hot-extruded from billets *continuous-cast* by Scovill's pioneer process. This means sounder metal — smooth, dense, free from pits or porosity. It means new uniformity of chemical composition, with optimum and uniformly distributed phosphorus content.

The next time you have a new installation or a re-tubing job, let us show you how these differences in Scovill Heat Exchanger Tube work for you.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

130C88

STATESMEN OF TECHNOLOGY

within the shadows of the ancient Roman Forum an unusual type of diplomacy is at work. Meeting at the Fourth World Petroleum Congress, representatives from many countries have assembled in Rome to discuss mutual problems and to survey the latest developments in the science of petroleum. By this means, the free exchange of ideas and experiences is facilitated among men who are drawn together by the universal desire for progress and success.

And success will be theirs . . . success that will be measured in far greater terms than in the advancement of an industry. For, with their unhampered search for new ideas every member of the Congress becomes a statesman for the free world . . . statesmen of technology . . . and truth.

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS

PROCON (CANADA) LIMITED—40 ADVANCE ROAD, TORONTO
PROCON (GREAT BRITAIN) LIMITED—112 STRAND, LONDON

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

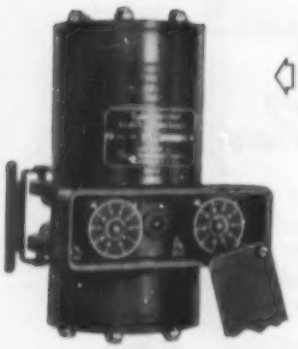
PROCON®

Eight reasons why Taylor

IS ORDERED

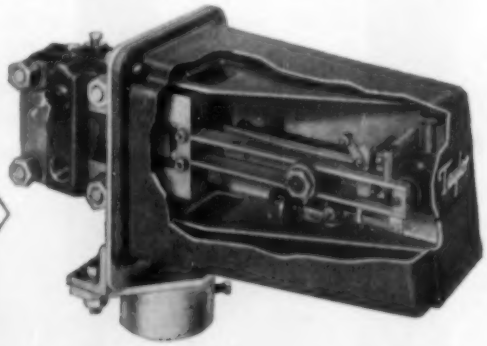
1 VERSATILITY	2 ECONOMY
5 DEPENDABILITY	6 EFFICIENCY

CONTROLLERS



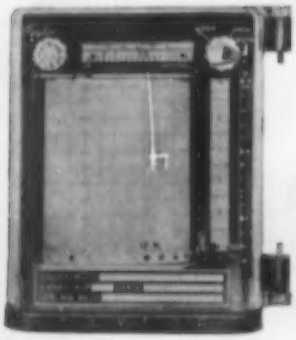
One Knob Bi-ACT® Controller provides single adjustment for reset and proportional response for flow applications. **The Two-Knob Bi-ACT Controller** gives you full range of adjustment of proportional and automatic reset responses: for all jobs that don't require derivative adjustment. **360R TRANSET Controller** provides independent adjustment of proportional and automatic reset responses; also available as a proportional response controller. **TRI-ACT® Controller** combines all three response adjustments—gain, reset rate and (derivative) PRE-ACT® response.

TRANSMITTERS



The Taylor TRANSAIRE® Differential Pressure Transmitter provides lower installation and maintenance costs along with sustained accuracy, because the unit may be mounted for self-draining or venting; also elimination of zero drift and range change during continuous use. **TRANSAIRE Temperature Transmitter** features short range spans within limits of minus 375 and +1000°F. Highly sensitive and responsive to dynamic temperatures due to lack of dead spots, derivative action in measuring circuit, and low heat capacity of cigarette-sized bulb. **TRANSAIRE Pressure Transmitter** is available in short range spans. Accurate to ½% of the selected short range span and sensitive to pressure changes of ½" of water.

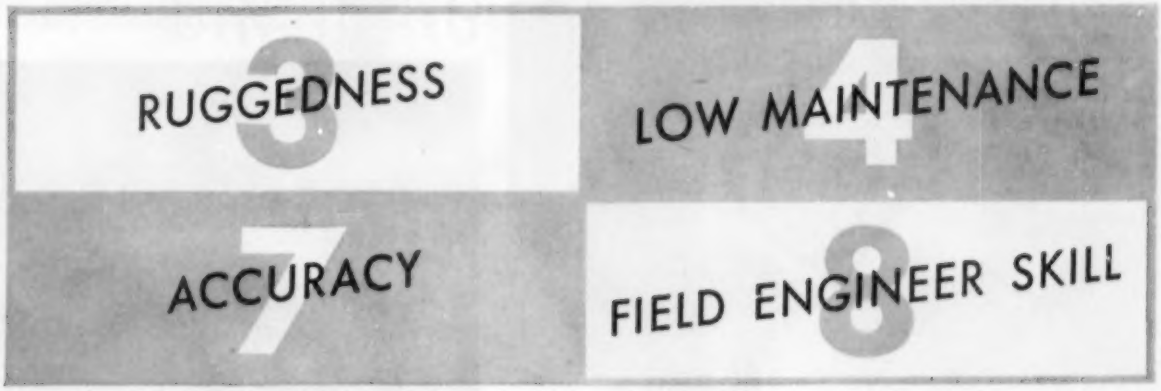
RECEIVERS



The TRANSET Recorder has automatic-manual unit, remote set-point indicator. 30-day linear chart, three hours visible. Chart reads from left to right on rectilinear coordinates, for quicker and easier operator interpretation. Twelve different forms of recording, and eleven different forms of indicating receivers available—all interchangeable with the self-purging case and all accommodated by one standard panel cutout (5 1/32" x 4 3/32")—even cascade control.

TRANSET® System

AND RE-ORDERED!



1 **Versatility**—quick, easy interchangeability of controllers and receivers—thanks to the Taylor Plug-In feature—makes it possible to trace, analyze and correct process difficulties before serious trouble arises. Transmitters have wide range adjustments built in.

2 **Economy**—you save money on installation because of simplified mounting, fewer piping connections, reduced panel size, lower labor and material costs. e.g., it's cheaper to run copper tubing than to pull thermocouple wire through a conduit. And transmitters can be located at point of temperature measurement or flow transmission, thus no long lead lines, no seal pots, no leveling required.

3 **Ruggedness**—flow transmitters will hold calibration—no zero shift even on long continuous service. Temperature transmitters have been used on top of columns 90 ft. high with ambient temperatures varying from 100° to minus 50°F.

4 **Low Maintenance**—small motions, low stresses and sturdily built parts make for minimum maintenance. Flow transmitters can be mounted close to pipe and are self-draining and venting. No permanent damage from overrange.

5 **Dependability**—Plug-In means minimum instrument down-time, maximum production efficiency. You're back on automatic control in seconds.

6 **Efficiency**—exceptionally fast speed of response in all three transmitters means processes can be measured the moment they start to change. Hence, better overall control, higher yield of quality product, less rerun.

7 **Accuracy**—temperature transmitters give fine accuracy of measurement because of narrow spans, extreme sensitivity, minimum dead spot, compensation for ambient temperature and pressure change. Flow transmitter produces accurate readings by elimination of long lead lines. Calibration holds on all transmitters, giving excellent repeatability.

8 **Field Engineer Skill**—Taylor's widespread force of Field Engineers have wide process equipment and application knowledge and experience in diverse industries.

• • •

Why not call in your Taylor Field Engineer now, or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

*Trade-Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

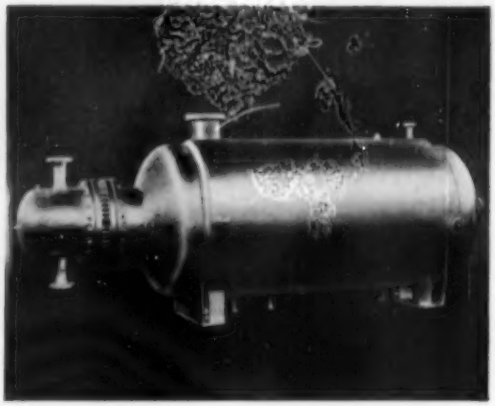
For more data on advertised products, use Readers' Service Cards, last page.

ECONOMY
High-alloy layer—usually 10% or 20% of total plate thickness—assures corrosion and abrasion resistance, long equipment life.

DESIGN FREEDOM
Integral bond allows design and fabrication of shapes to meet process and space needs.

STRUCTURAL STABILITY
Low-cost carbon steel backing provides necessary strength and rigidity.

Nickel-clad steel gives this jacketed heating unit high corrosion resistance in processing light hydrocarbons and dilute hydrochloric acid.



CLAD STEEL EQUIPMENT PERMITS

FULL DESIGN FREEDOM

When new equipment is being planned, economical clad steels will assure maximum design freedom for your tanks and pressure vessels. Because of the integral bond between high-alloy cladding and the carbon steel backing plate, full gage consideration is permissible under the API-ASME Code. Clad can be readily worked by conventional fabricating tools and methods, permits easy and economical field erection. In service, clad steel helps protect against unscheduled shut downs stemming from seepage or crevice corrosion.

Clad steels offer you all the corrosion resistance of solid, high-alloy construction with savings up to 50% in material costs. These and other benefits, easy cleaning, drainage inspection or modification, can be obtained from 16 cladding materials—various types of stainless, nickel, Inconel, Monel, copper.

These are supplied with a standard sodium hydride finish, or may be polished to help improve performance characteristics. When you're thinking of new tanks and vessels, qualified equipment builders can help your engineers and consultants take advantage of versatile Lukens' Clad Steels. We work closely with fabricators to help select the type most suited to your processing needs. To get more information, ask one of your equipment builders, or write Manager, Marketing Service, Lukens Steel Company, 751 Lukens Building, Coatesville, Pennsylvania.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

INTERESTED IN UNIFINING* FOR DESULFURIZATION AND UPGRADING

• First Commercial Unifining Unit
United Refining Co.
Warren, Pennsylvania

UNIFINING should be of particular interest to all operators of catalytic reformers which produce by-product hydrogen.

• Harshaw is the exclusive producer of the Union Oil Company of California cobalt-molybdate catalyst used in the recently announced "Unifining" desulfurization and upgrading process. This rugged, commercially proven catalyst is supplied in the form of cylindrical tablets conforming to rigid physical and chemical specifications established by Harshaw and Union Oil Company of California. Stability at high temperatures permits repeated regenerations if and when necessary.

Please contact Harshaw for further information on this catalyst.

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 East 97th Street, Cleveland 6, Ohio

Chicago 32, Illinois • Cincinnati 13, Ohio • Detroit 28, Michigan • Houston 11, Texas
Los Angeles 22, California • New York 17, N. Y. • Philadelphia 48, Pennsylvania
Pittsburgh 22, Pennsylvania

* Trademark of Union Oil Company of California

For more data on advertised products, use Readers' Service Cards, last page.

From one source . . . any instrumentation you need

When it comes to measurement and control, every industrial process is different. Each demands its own combination of accuracy, economy, instrument ranges, and all the numerous other characteristics that are peculiar to the individual application.

No single instrument and its accessories could possibly fit every process. So Honeywell makes a broad variety of measuring and controlling equipment that spreads across a tremendous range of applications.

The advantages are two-fold. First, you can get all the instrumentation your process requires from a single source, so there is undivided responsibility for the complete installation. And second, you are assured that the equipment selected for your process is recommended without bias . . . neither over-sells nor under-equips . . . needs no stretching, squeezing or compromising to fit it to its assignment.

This versatile family includes *ElectroniK* indicators, recorders and controllers in circular and strip chart models, applicable to temperature, pressure, pH, power and dozens of other variables: square root flow meters for control applications; evenly graduated flow meters for cost accounting; thermometers, pressure gauges and liquid level meters; *Pyr-O-Vane* millivoltmeter controllers. Especially useful for graphic panels are the *Tel-O-Set* miniature indicators, recorders and controllers. Electric and pneumatic control systems range from the simplest to the most complex, including automatic program controls and complete systems developed for particular processes.

Working with these instruments is a full choice of primary elements . . . thermocouples, *Radiamatic* radiation elements, pressure-type and electrical resistance thermal systems, flow meter bodies, pH cells and many others. For final control elements, you can choose from a wide range of electric motorized and diaphragm operated valves. To complete the picture, there are more than 7000 non-indicating devices for controlling temperature, pressure, vacuum, liquid level and humidity . . . an unmatched variety of instrumentation made by the world's largest manufacturer of control equipment.

Honeywell cascade control maintains accurate reheater

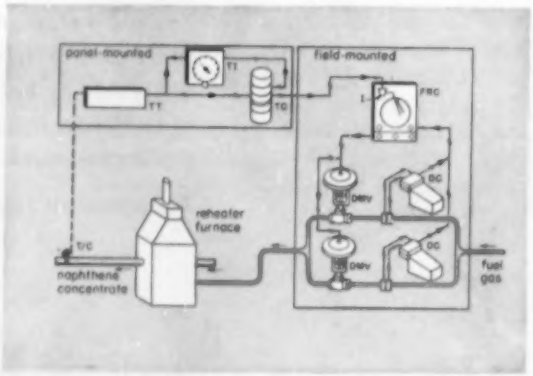
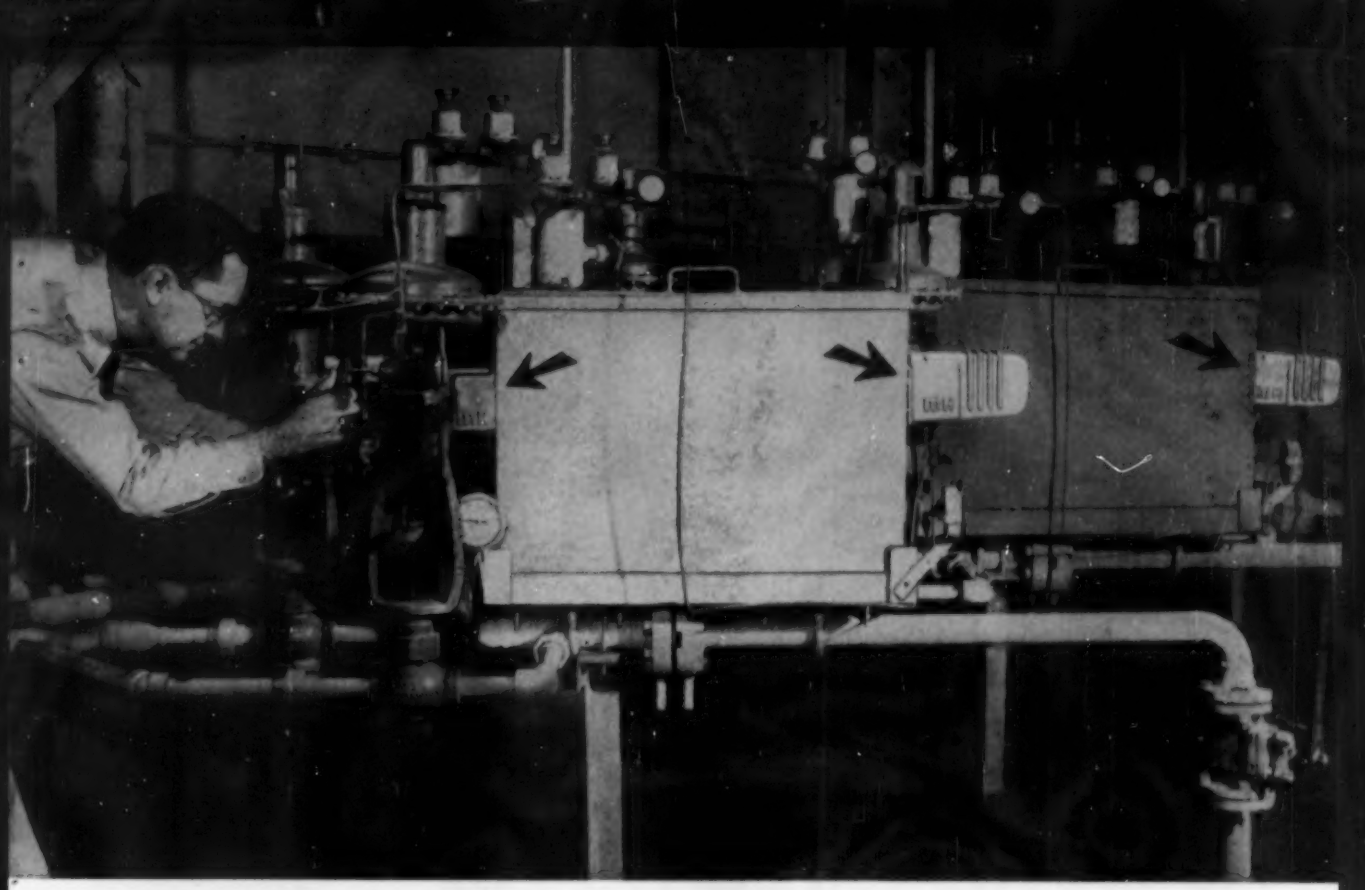


Diagram shows basic elements of temperature control system. Grouping ***Tel-O-Set*** *indicator, controller and temperature transmitter together minimizes control tubing runs . . . simplifies tuning of control action.*



Flow of fuel gas to reheater furnaces is transmitted to nearby controller by ***Differential Converters*** *(see arrows). Cascade control system actuates diaphragm valves in each line.*

temperatures in Sun Oil Plant

SUN OIL COMPANY'S $15 million petrochemicals plant at Marcus Hook, Pa., makes use of the most advanced control techniques to assure efficient production. Designed to produce toluene, benzene, xylenes and numerous valuable by-products . . . the plant features Honeywell graphic centralized control, plus supplementary field-mounted instrumentation in specific spots where local data is needed.

The Honeywell cascade system used to regulate reheater furnace temperature typifies the intricate control instrumentation required for many processes. The furnace feeds the *Houdriformer* unit, and must supply widely varying Btu output depending on the end product. The furnace has considerable control lag, and fuel gas may vary in composition and pressure. To overcome these factors, a *Tel-O-Set* instrument on the main panel measures temperature of heated stock and resets the control index of a Brown Flow Controller. The flow instrument is located near the furnace where fireman can check readings. This controller, in turn, regulates diaphragm valves in the two fuel gas lines supplying the furnace. Adjustable limit stops in the flow controller's *Indexet* unit prevent closing of the gas valves beyond safe limits during sudden surges in temperature. The result is exceptionally consistent, close-limit control.

Numerous other specialized control applications can be readily handled by Honeywell custom-designed cascade and ratio systems. A broad variety of instrumentation, and an extensive background of experience in petroleum processing control are ready to serve you. Your local Honeywell sales engineer will welcome the opportunity to discuss your specific application . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:**
Write for Catalog No. 2320 and Bulletin No. 8410

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

H HONEYWELL

First in Controls

PRITCHARD RECOVERS SULPHUR FOR SIGNAL!

SIGNAL OIL AND GAS COMPANY'S TIOGA, NORTH DAKOTA, SULPHUR RECOVERY PLANT COMPLETES FIRST WINTER OF OPERATION.

Pritchard designed and engineered this plant to extract hydrogen sulphide and produce 65 tons of elemental sulphur per day in an extremely cold climate.

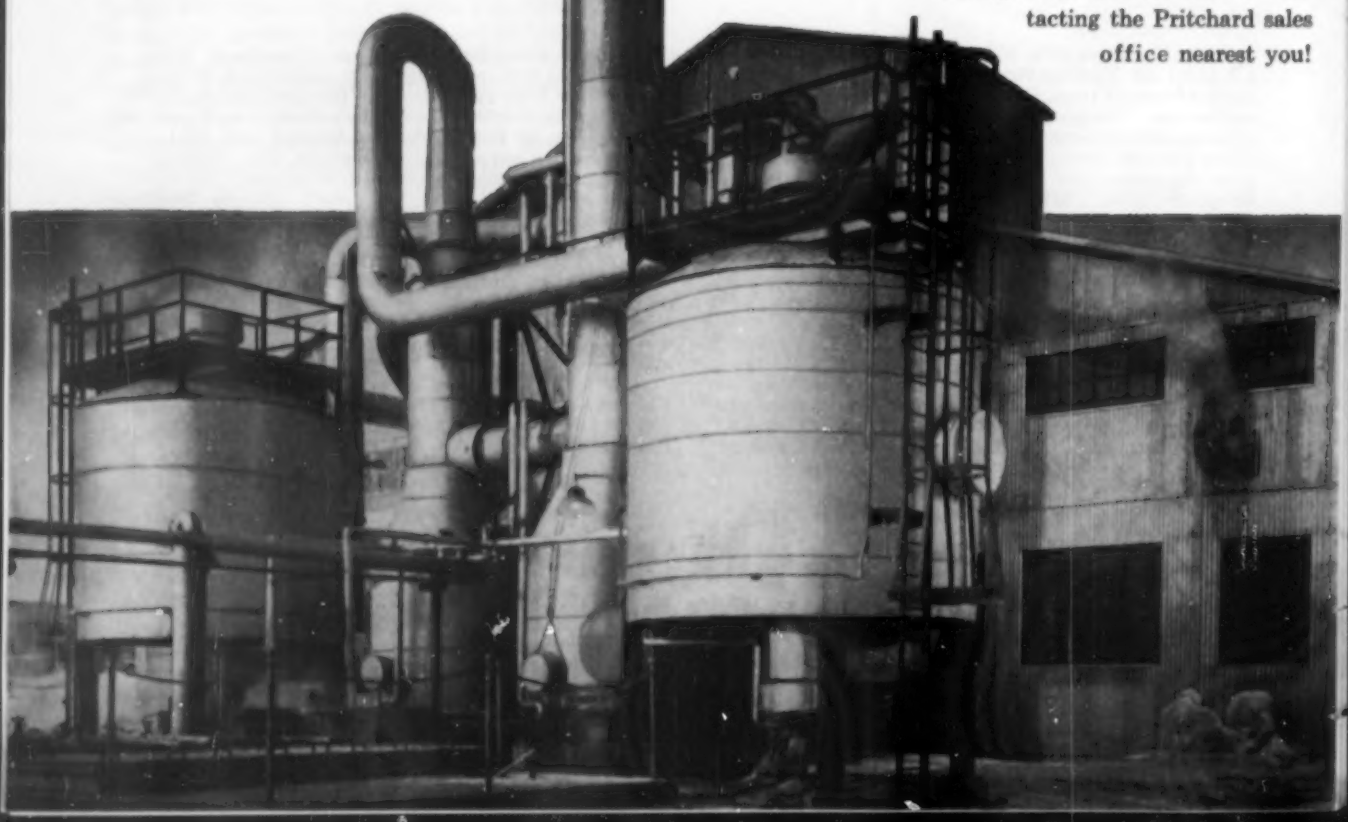
Pritchard has available patented processes, practical design data, and operating specifications to provide efficient sulphur recovery for *your* refinery or natural gas operation. Take the first step toward turning waste into profits by contacting the Pritchard sales office nearest you!

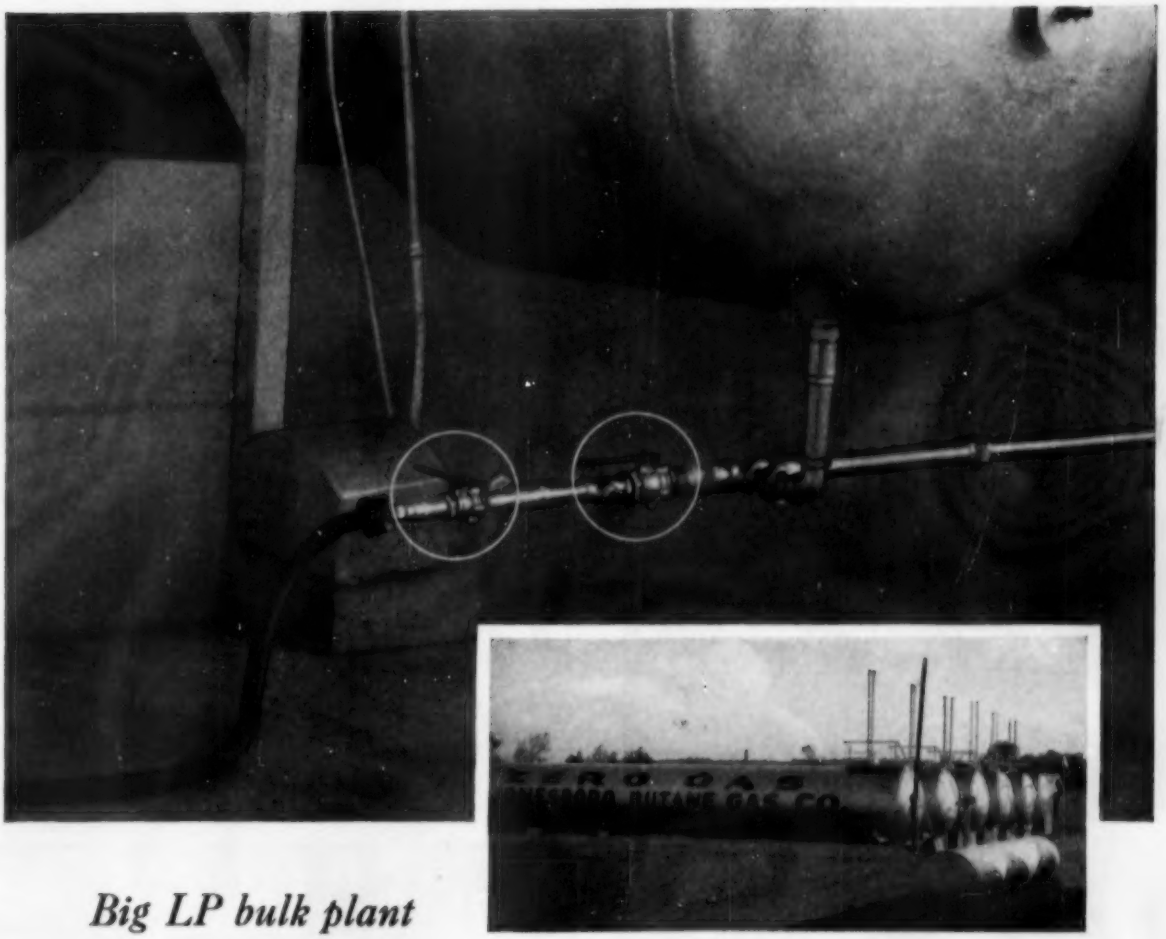
INDUSTRY'S RANKING FOR PROGRESS

J.F. Pritchard & Co.

ENGINEERS • CONSTRUCTORS

Dept. 463, 4525 Roanoke Parkway, Kansas City 12, Mo.





Big LP bulk plant safeguards loading lines with full round flow Rockwood Ball Valves

Conventional valves on the loading lines were causing a delay at this busy bulk plant. Hoses burst, due to expansion of the liquid by the morning sun, and leakage was a problem.

Rockwood Ball Valves ended these annoyances. Since their installation not a hose has been lost — and their extra fast opening and closing, plus elimination of leakage, have brought new speed and safety to loading operations.

There are four good reasons why Rockwood Ball Valves are such outstanding performers — four exclusive features for trouble-free efficiency:

Full Round Flow — no change in shape or volume of fluid stream — no turbulence.

Quick Opening and Closing — only a quarter turn needed, even under full pressure — a time saver.

Longer Wear Resistance — chrome-plated bronze ball withstands abrasion, pitting and scratching.

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal. Retainer spring holds ball tight on seat at no pressure.

If you are not now using Rockwood Ball Valves, send coupon today for complete information. Valves come in all pipe sizes — ¼" to 2½" in bronze — 3" to 8" in steel. Tested and listed by Underwriters' Laboratories, Inc. Ask for Rockwood air-operated ball valves for remote control use. Distributors in all principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
566 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....

Title.....

Company.....

City.....

Zone.....*State*.....

For more data on advertised products, use Readers' Service Cards, last page.

Take a tip for safety's sake...

safe-tread with Multigrip!

OVERHEAD RAMPS

DON'T WAIT until *after* a serious accident occurs! It will cost you less—in money and man-hours to safe-tread with USS Multigrip Floor Plate right now.

Then you'll know that your workers are protected from slips and falls at all times—even when the floor is wet or oily. For Multigrip safe-treading provides sure-grip traction from any direction for wheels as well as for feet. Be sure you don't overlook *any* potential danger spot, any area where a smooth surface may cause a slip.

Multigrip is easy to install . . . it is available in large sections so that you can reduce cutting time and waste when you want to cover large areas. Multigrip also is easy to keep clean, with broom or hose. There are no crevices to catch dirt . . . water drains quickly and completely.

Multigrip makes a long-lasting floor. This tough steel plate can take years of heavy traffic—and it won't crack, chip, splinter or rot as other flooring materials do. Multigrip can be used structurally or as a covering.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

STEPS OR RAMPS

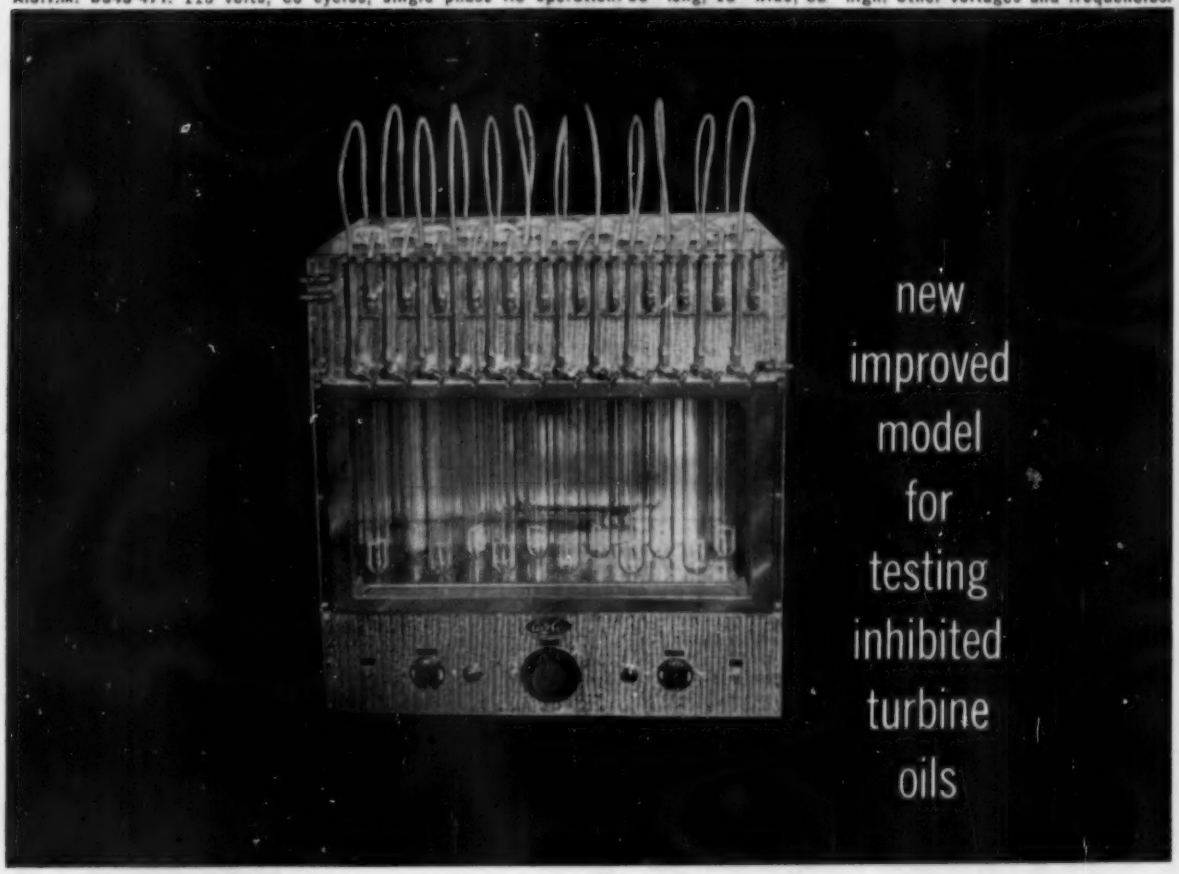
ENTIRE PLANT FLOOR

USS multigrip
FLOOR PLATE

Sold by leading distributors from coast to coast B-1003

UNITED STATES STEEL

A.S.T.M. D943-47T. 115 volts, 60 cycles, single phase AC operation. 30" long, 18" wide, 32" high. Other voltages and frequencies.



turbine oil oxidation bath

This bath determines the oxidation inhibitor life of inhibited turbine oils. The oil sample, in the presence of water, oxygen and an iron-copper catalyst, is subjected to a temperature of 95°C ± 0.2°C.

The bath accommodates 12 oxidation test cells. It is made of corrosion resistant stainless steel. It utilizes "flow-rater" type flowmeters, made of pyrex brand glass, with stainless steel floats. Individual needle flow control valves assure a rate of flow of three liters of oxygen per hour to each test cell. The water manifold has valve connections for mushroom type condensers.

The bath's window is made of tempered polished "Tuf-flex" plate glass. Two fluorescent lamps permit the operator to view the rate of oxidation and eliminate the need for removing the cells in determining sample level. A stainless steel centrifugal pump accomplishes uniform stirring without turbulence.

In conjunction with the lo-lag stainless steel heaters, a sensitive mercury-in-glass-type thermoregulator operates a mercury plunger relay on the intermittent heat circuit. Another bank of heaters quickly brings the bath up to operating temperature. An additional heater circuit permits steady continuous heat input. All control knobs are conveniently mounted on the lower front panel for ease of operation.

PRICE LIST

G18765	Steam Turbine Oil Oxygen Bath, 12 unit improved model, complete as described above but without oil test cells (which consist of test tube, mushroom condenser and oxygen delivery tube).	each	$1,750.00
G18772	Oil Tube Pyrex brand glass	each	3.75
G18774	Mushroom Condenser Pyrex brand glass	each	7.00
G18776	Oxygen delivery tube	each	4.50
G18778	Copper wire catalyst per 1000 ft		11.50
G18780	Iron wire catalyst per 1000 ft		6.00
G18782	Winding fixture for wire catalyst	each	150.00

Send for "Labitems" describing Oxidation Bath and other new petroleum testing instruments

75 years 1880-1955

20-26 N. MOORE STREET DEPT. 235, N. Y. 13, N. Y.

The EMIL GREINER Co.

For more data on advertised products, use Readers' Service Cards, last page.

WHAT'S NEW AT BRISTOL

FIRST instrument system
BASIC GRAPHIC-PANEL

It's BRISTOL'S new metagraphic instrument system

A WIDE SELECTION: For example, there are 35 receiver and 34 controller models and the widest variety of transmitters on the market. A model can be found among these that will exactly meet any requirement.

FULL PLUG-IN SERVICE: Change recorder to an indicator or vice versa in 10 seconds with ABSOLUTELY NO INTERRUPTION WHATSOEVER TO AUTOMATIC CONTROL.

Pull complete chassis out (one piece chassis — no tools required). With chassis removed you get the same automatic control as before.

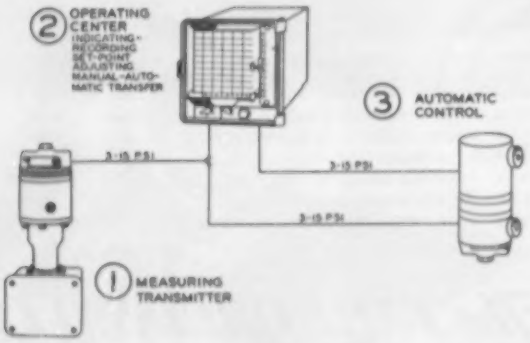
Change from one model to another or if trouble is suspected in a plug-in unit, the doubtful unit can be replaced by a spare while the suspected unit is checked in the service shop — out-of-service time is thus eliminated.

CONTINUOUS VALVE POSITION INDICATION on *same instrument scale as set point scale*, gives continuous data on control valve position—makes "bumpless" transfer possible, simply by matching pointer positions — no need to read actual scale values — minimizes reading errors — speeds operations.

METAGRAPHIC TRANSMITTER

SUPPLIED IN A VERY WIDE VARIETY OF SPANS AND RANGES: For example, absolute pressure instruments are made in ranges as low as 5mm mercury absolute. Pressure instruments as low as 5 inches water to 10,000 psi. Over-range protection available up to 400% over range.

STANDARD BRISTOL MEASURING ELEMENTS ARE USED — high torque, wide-angle travel gives powerful, positive operation. Very sensitive — as little change as 0.03% of range, including reversal.

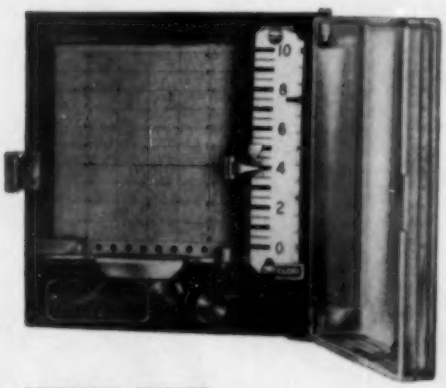


METAGRAPHIC INSTRUMENTS MEASURE, RECORD, INDICATE, AND AUTOMATICALLY CONTROL

Pressure	Liquid Level
Vacuum	Flow
Absolute Pressure	Temperature and
Differential Pressure	Mechanical Motion

For more data on advertised products, use Readers' Service Cards, last page.

that carries out idea completely!

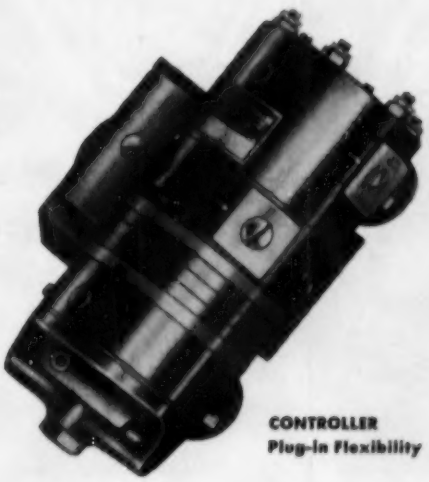


RECORDING RECEIVER:
Also furnished as an Indicator

NO INTERRUPTION WHATEVER TO AUTOMATIC CONTROL when receiver chassis is removed. The chassis of a Metagraphic Receiver is plug-in construction and can be changed from a recorder to an indicator or back in a matter of 10 seconds.

OFFERED FOR UP TO 3 MEASURED VARIABLES — with air pressure regulators or air-loaded regulators — three-position manual-automatic transfer valves for automatic control and *six-position (on the same knob) transfer valves for cascaded control.*

ALL MEASUREMENTS ON SAME SCALE PLATE: Deviation of pointers shows at a glance conditions of control — no need to read scale.



CONTROLLER
Plug-in Flexibility

VARIETY AND FLEXIBILITY: The most flexible and complete line of controllers offered — 34 different models, including the following variations:

1. **Remote set-point**
2. **Integral set-point (with or without air-loading)**
3. **Pipe-connected**
4. **Plug-in receiver mounted**
5. **Plug-in pipe or surface mounted**
6. **Five models of control action as follows:**
   a. **On-Off**
   b. **Adjustable proportional**
   c. **Adjustable proportional plus reset**
   d. **Fixed proportional plus reset**
   e. **Proportional plus reset plus rate (derivative)**

Write for our product data sheets. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

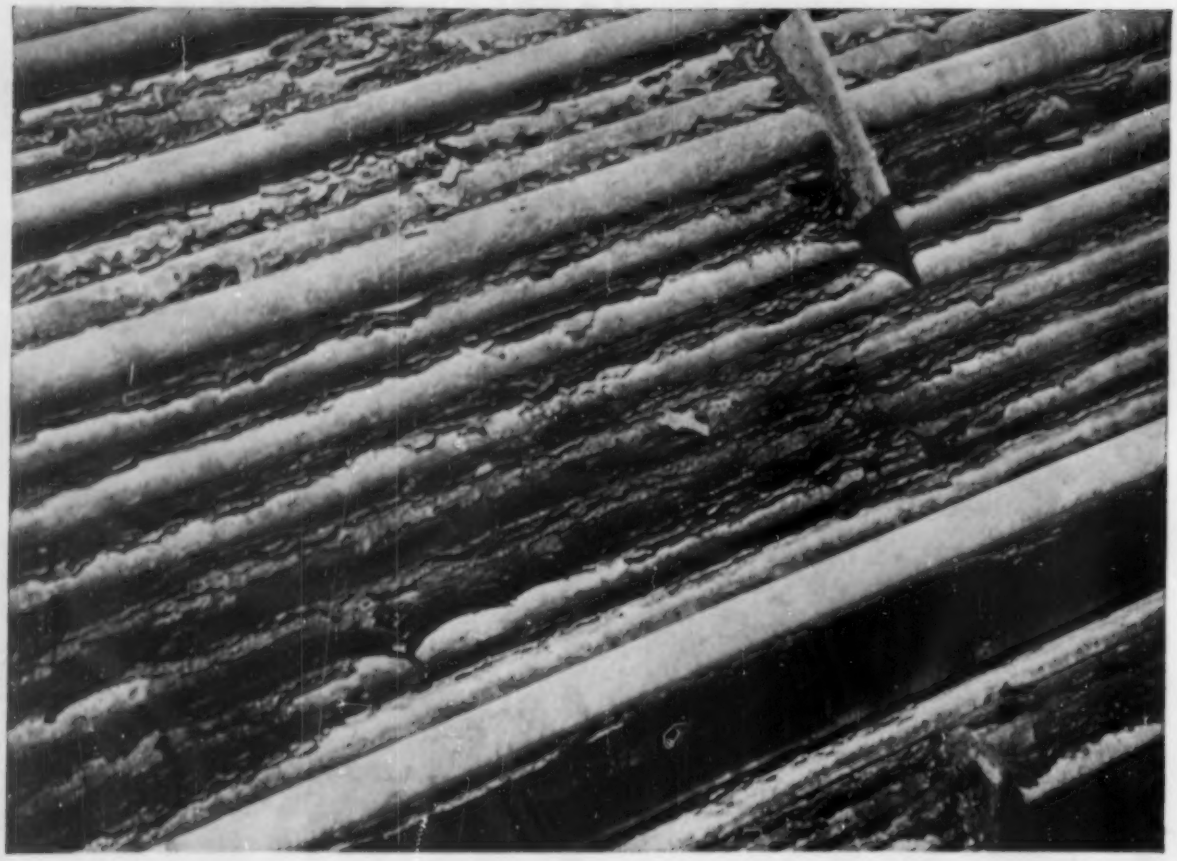
6.5.2

BRISTOL'S

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



WHY PAY FOR THIS?

Why pay for fouling when Polyrad costs so little? Frequent down time for cleaning or replacing fouled and corroded equipment is no longer a normal operating expense for refineries. Not when Polyrad corrosion inhibitor can prevent damage with an average treatment of about 1 quart of Polyrad per 1,000 barrels of fluid.

Polyrad's powerful detergent action loosens organic and inorganic deposits and permits their removal in the fluid stream. This means you can prevent fouling by using Polyrad—and you can even clean up fouled equipment by starting Polyrad treatment. All around the refinery, Polyrad helps maintain throughput, increases heat transfer, reduces metal loss, and cuts down time for maintenance.

Polyrad is readily available from stocks maintained throughout the country. A Hercules technical representative will be glad to assist in evaluating Polyrad under your own operating conditions.

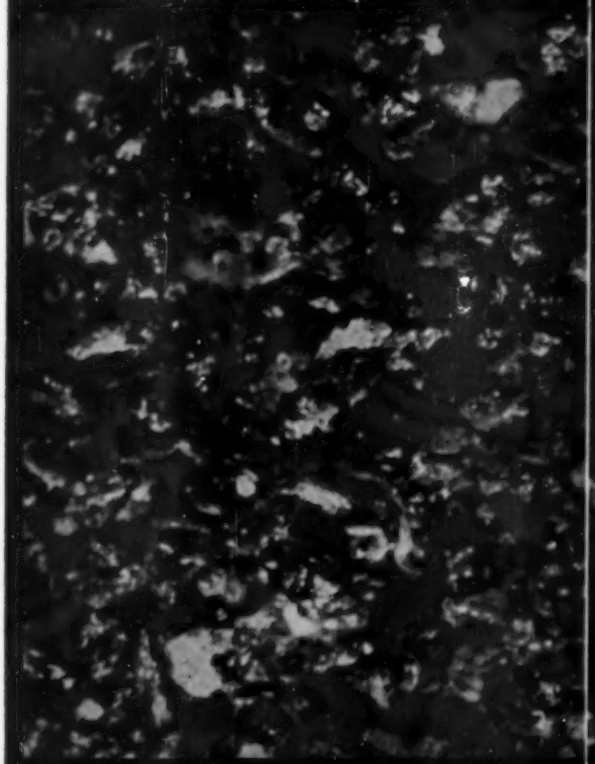
Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
976 Market Street, Wilmington 99, Del.

POLYRAD®
FILMING AMINE INHIBITOR

8A50-2

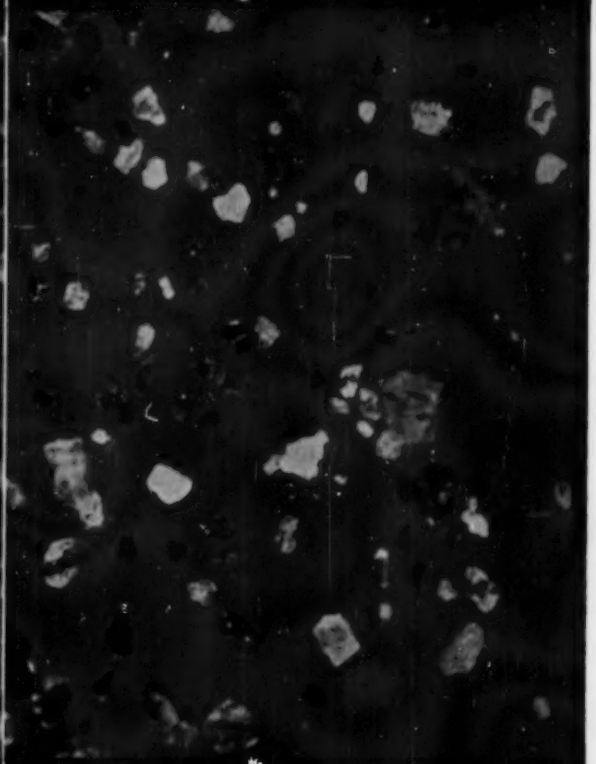
quantitative and qualitative PROOF

1. That "clean," ready-to-refine crude oil often contains harmful solids in substantial quantities.



The photomicrograph above (70X) shows the solids, or sediment, contained in about one half quart of supposedly "clean" refinery charging stock.

2. That they are effectively removed by PETRECO Electric Desalting.



This photomicrograph (also 70X) shows the sediment remaining in the same quantity of oil after it had been purified by Petreco Electric Desalting.

The removal of harmful solids from charging stock is an additional benefit derived from the use of Petreco desalting. In addition to removing 95% to 100% of the salts, Petreco desalting also insures against plugging and abrasion damage from solids such as those illustrated above. Along with the salts, these detrimental substances are brought together in the electric field, caused to associate with the water phase and are eliminated in the effluent water.

For maximum refining efficiency, specify Petreco Electric Desalting. Complete information is available from

PETRECO A DIVISION OF PETROLITE CORPORATION

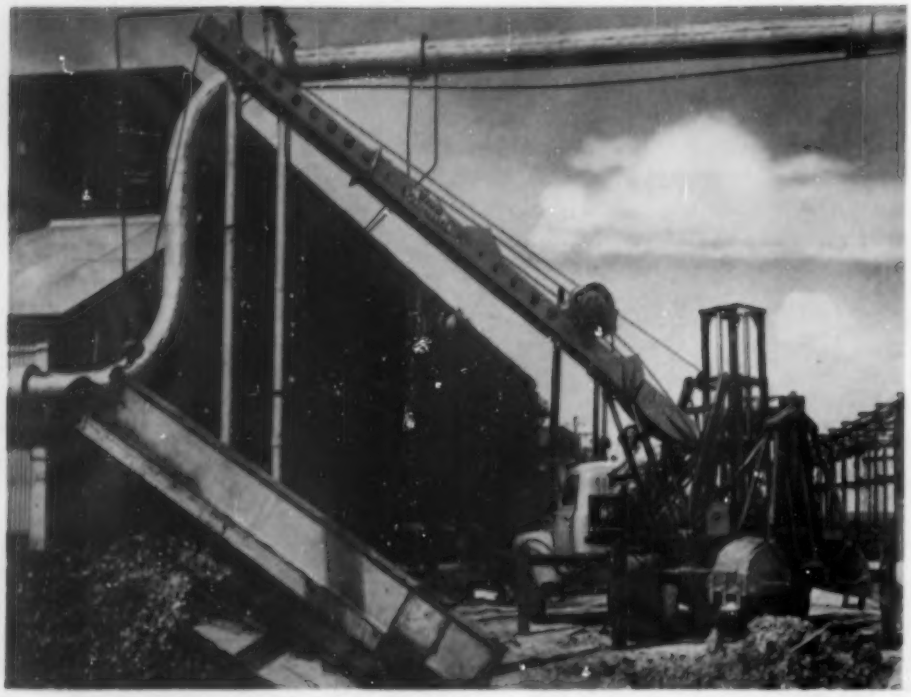
3202 South Wayside Drive, Houston 1, Texas
1390 East Burnett Street, Long Beach 7, California

PETRECO®

Specialized Electric Petroleum Processing

DEHYDRATING • LUBE OIL TREATING • DISTILLATE TREATING
DESALTING • SEDIMENT SEPARATION • DESAPONIFICATION

DS-5



Here's precision hydraulic power and control in action. This Bucyrus-Erie Hydrocrane is setting tank foundations at a Southwest refinery. Smooth, positive metering action through hydraulic controls protects costly equipment against damage — provides utmost safety for men.

Costly Jolts Gone—Fluid Action Hydrocrane Gives Cushion Handling to Growing Range of Jobs

About seven years ago the revolutionary Bucyrus-Erie all-hydraulic Hydrocrane first demonstrated its almost unbelievable precision control. On one test it lifted, swung and set down a pyramid of six brimful drinking goblets, carried on a 1-ton steel test slab — without spilling a drop of water. Today greatly improved Hydrocranes and Hydrohoes with greater capacity and far faster line speeds are bringing this outstanding hydraulic precision to an ever increasing number of jobs.

Every crane or hoe function is fully hydraulic — swing, boom hoist, line hoist, boom telescope, outrigger control.

To fully realize the advantages of fluid power and control, you must see a Hydrocrane in action — moving heat exchangers, handling condensers, setting valves and pipe, stockpiling material, erecting tank foundations . . . countless digging, erecting and clean-up jobs. Your Bucyrus-Erie distributor will demonstrate on your job. 62H55

Wrist-action Hydrohoe speeds trenching. Wrist-action dipper is hinged at lower end of boom handle and rotates under power to produce bigger loads, better trenches, more biting force, less spillage. Hoe gives you the same precision control, boom telescope, and smooth action of the Hydrocrane. Quickly convertible to crane boom in the field.

BUCYRUS ERIE
South Milwaukee Wisconsin

1880 75 1955
YEARS OF SERVICE to Men Who Shape the Earth

For more data on advertised products, use Readers' Service Cards, last page.

New Houdresid Process Completely Cracks the Bottom of the Petroleum Barrel, Increases Gasoline Yields.

The Houdry Process Corporation has announced an economically feasible process for catalytically cracking the bottom of the petroleum barrel. The new process, named *Houdresid*, converts reduced crudes into the most desirable refinery products.

Houdresid eliminates the need for expensive feed preparation processes. It also accomplishes a marked increase in gasoline yield; approximately 64 per cent gasoline is produced from the residuum as compared with 52.5 per cent gasoline yield from vacuum distillation plus catalytic cracking.

The Houdresid Process has been on stream for more than a year at the Sun Oil Refinery at Sarnia, Ontario.

For further information write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pennsylvania.

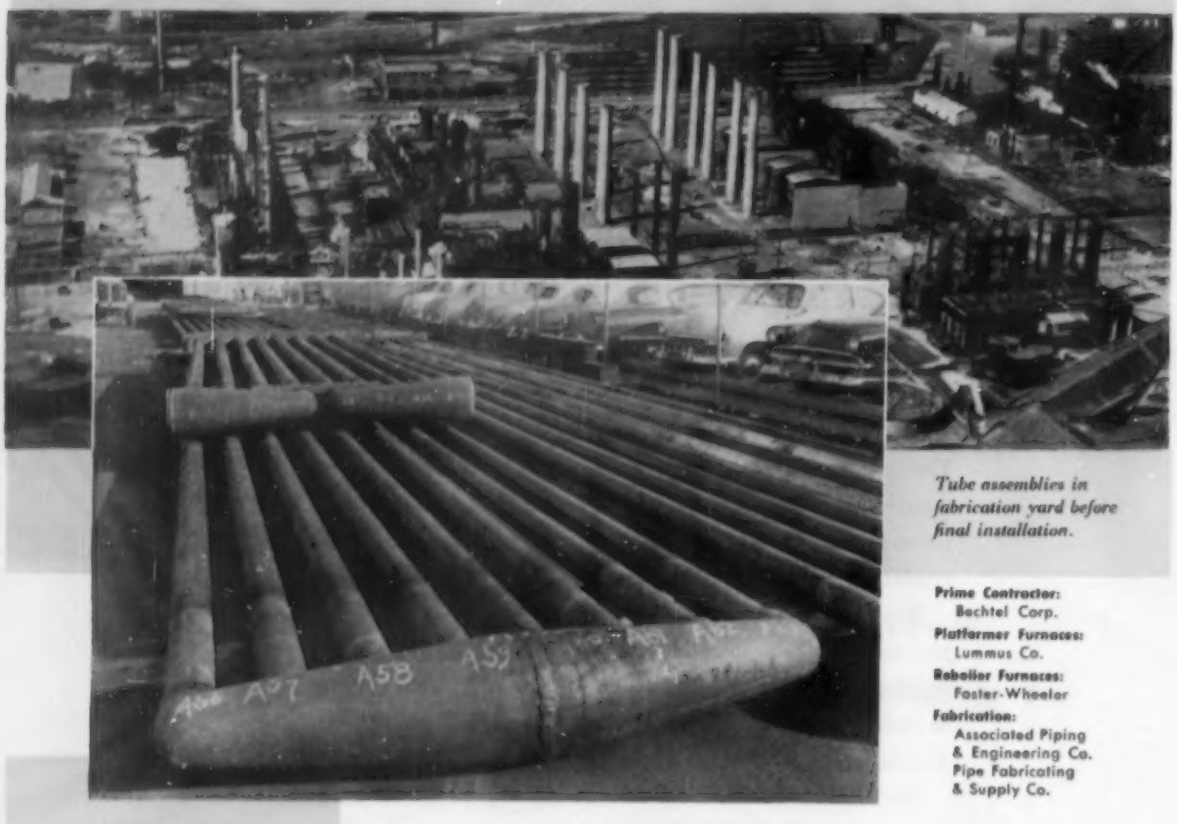
HOUDRY PROCESS CORPORATION

PIONEER IN CATALYTIC PROCESSES

For more data on advertised products, use Readers' Service Cards, last page.

KEY-KAST® FITTINGS

on Fabrication Assemblies for Platforming Charge Reheaters and Reboilers of Standard Oil Company of Calif.



Tube assemblies in fabrication yard before final installation.

Prime Contractor:
Bechtel Corp.

Platformer Furnaces:
Lummus Co.

Reboiler Furnaces:
Foster-Wheeler

Fabrication:
Associated Piping & Engineering Co.
Pipe Fabricating & Supply Co.

JOB DETAILS:

Tube size:	6⅝" O.D. x .675" minimum wall
Material:	2¼ % chrome, 1% molybdenum
Designed for: Pressure-temperature:	850 lb., 1125°F.

These specially-designed Key-Kast multiple-hole fittings were produced by Key Co. for installation in the new catalytic reformer units at Standard Oil Company of California's refineries at El Segundo (illustrated) and Richmond.

More and more refineries, in fact, are finding Key-Kast fittings and flanges the answer to their alloy piping needs. . . for these Key-Kast advantages mean greater structural strength and longer life:

- Greater wall thickness throughout
- Greater allowance for corrosion, with extra thickness at critical areas
- Controlled quality, through rigid metallurgical control

Key company

Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

Box 494-E, EAST ST. LOUIS, ILLINOIS

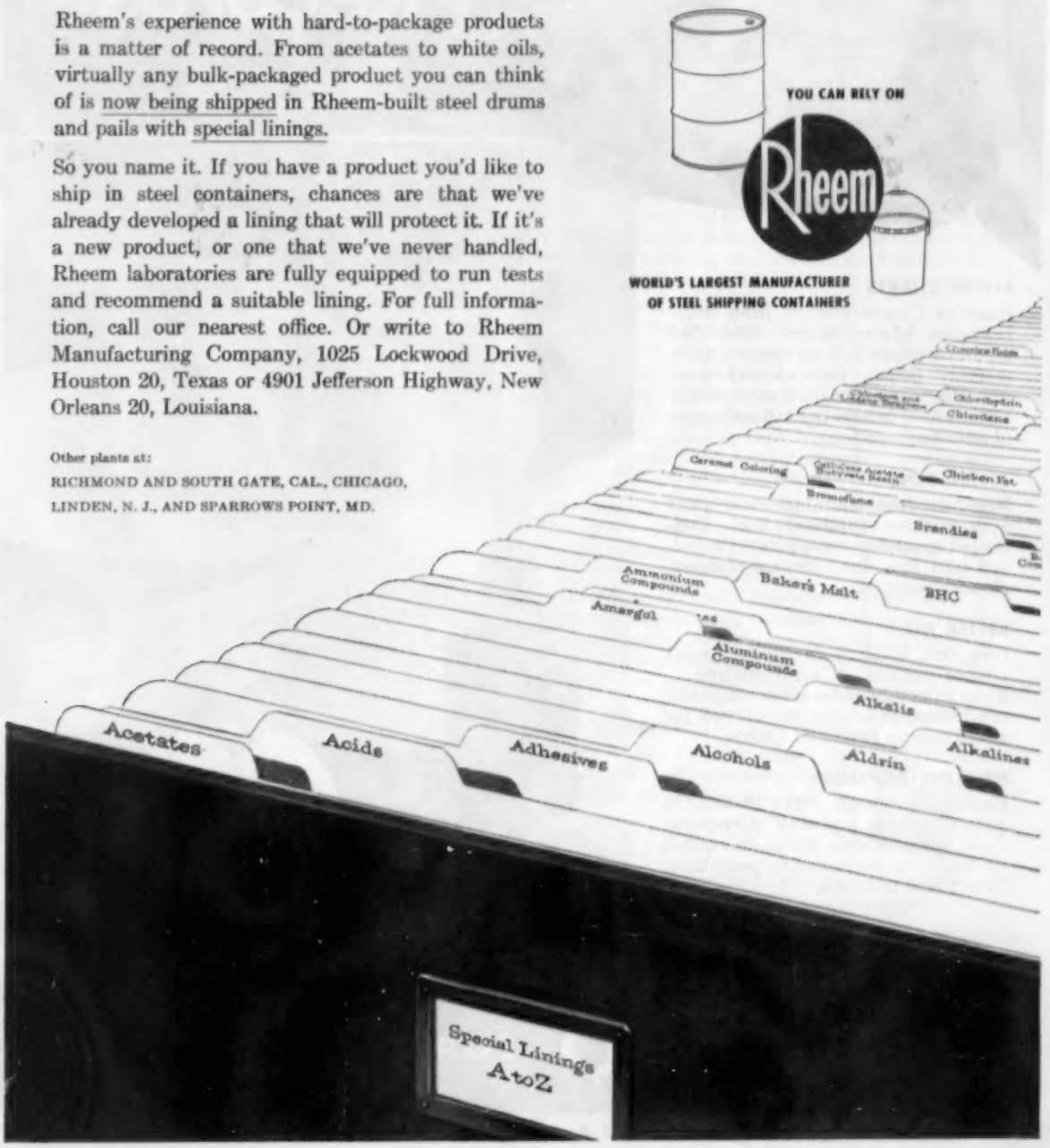
DISTRICT OFFICES: NEW YORK • CLEVELAND
CHICAGO • TULSA • HOUSTON • LOS ANGELES

Whatever your product, chances are that Rheem has already developed special linings to protect it for shipment in steel drums

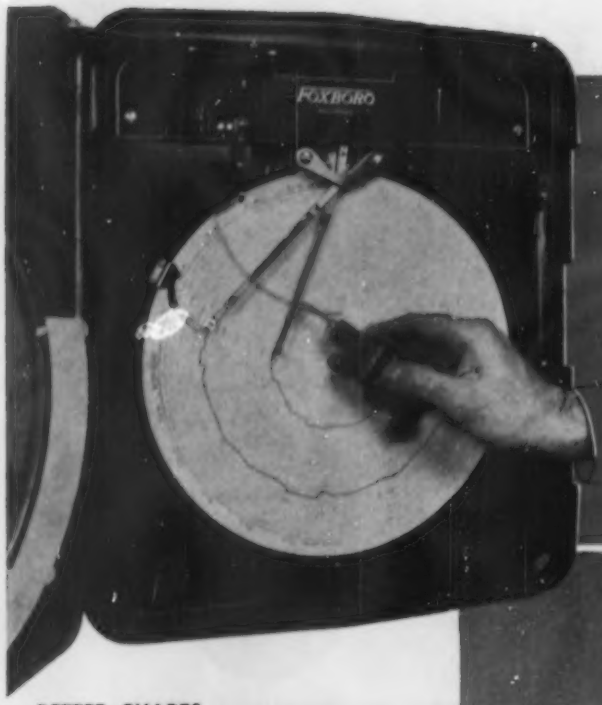
Rheem's experience with hard-to-package products is a matter of record. From acetates to white oils, virtually any bulk-packaged product you can think of is now being shipped in Rheem-built steel drums and pails with special linings.

So you name it. If you have a product you'd like to ship in steel containers, chances are that we've already developed a lining that will protect it. If it's a new product, or one that we've never handled, Rheem laboratories are fully equipped to run tests and recommend a suitable lining. For full information, call our nearest office. Or write to Rheem Manufacturing Company, 1025 Lockwood Drive, Houston 20, Texas or 4901 Jefferson Highway, New Orleans 20, Louisiana.

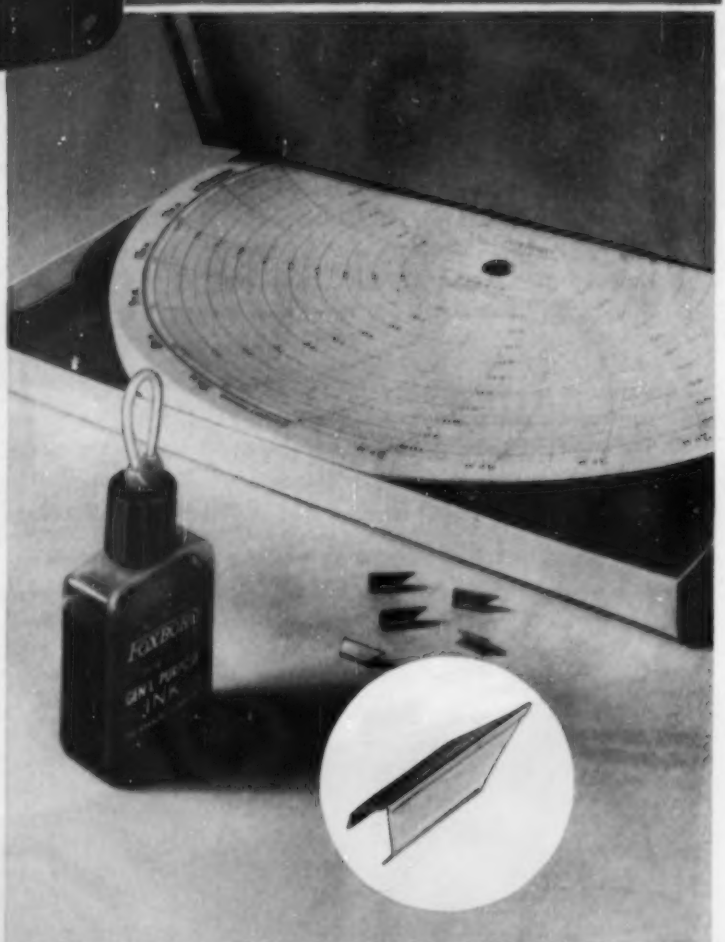
Other plants at:
RICHMOND AND SOUTH GATE, CAL., CHICAGO,
LINDEN, N. J., AND SPARROWS POINT, MD.



For more data on advertised products, use Readers' Service Cards, last page.



Better Records



BETTER CHARTS

Humitex Charts printed from high-precision plates, under controlled humidity conditions, on special, high-stability paper. Easy-to-read gray printing against chart's smooth, white background brings out full brilliance of new Foxboro Ink.

BETTER PENS

Non-corroding, stainless-steel pens with positive capillary feed. Controlled special-process points (standard and fine line) assure sharper, cleaner records.

BETTER INK

Five rich, brilliant colors . . . won't clog or "feather" . . . sediment-free . . . flows smoothly under all atmospheric conditions. Specially formulated for new Foxboro Pens and Charts.

NEW INK DISPENSER

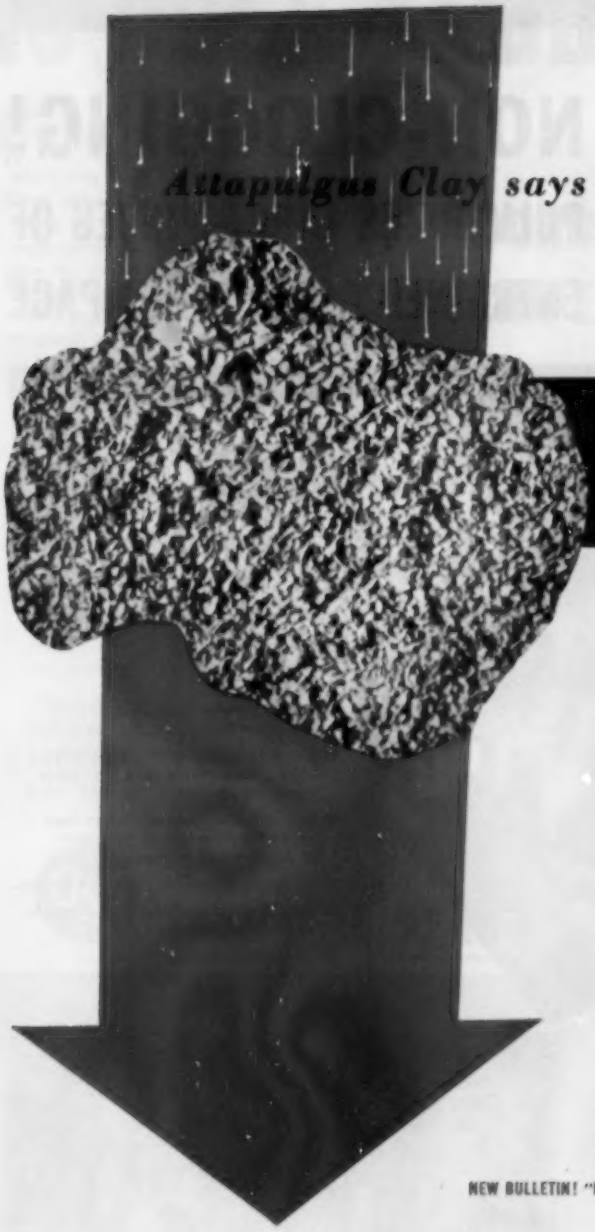
Exclusive-design, easy-to-handle polyethylene "squeeze" dispenser (pat. pend.) gives pin-point control of drop size, ends messy pen-filling. Won't leak or break.

THE FOXBORO COMPANY
746 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO REG. U. S. PAT. OFF. **FOR BETTER RECORDS**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Attapulgus Clay says **STOP!**



to
Platinum Catalyst
poisons

Attapulgus Clay keeps strict watch over your catalytic reforming feed stocks, protects you against losses caused by catalyst poisoning. It does this by effectively reducing the detrimental constituents that temporarily (sometimes permanently) foul the catalyst.

Here are the troublemakers (some need only be present at 10 parts per billion) that Attapulgus Clay adsorbs from the stream: ARSENIC—either present in the crude, or picked up from corroding tubes and equipment; LEAD—either crude-occurring or picked up; SULFUR—alkyl or aryl; NITROGEN—known to exist in some crudes, but whose source usually is in amine-type corrosion inhibitors.

Setting up this effective clay treatment safeguard can be accomplished at a surprisingly low investment—one that pays out promptly in terms of the most favorable production rate.

This is another solid example of how M&C products keep growing in value to refiners. There's always a *new place* for these versatile minerals to improve the quality and cut the processing costs of petroleum products.

NEW BULLETIN! "Preparation of Petroleum Feeds for Platinum Catalysts" *is just off press. Check the coupon for prompt mailing of your personal copy, and for other assistance, if desired.*

ATTAPULGUS **ATTAPULGUS PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
210 W. WASHINGTON SQUARE, PHILADELPHIA 5, PA.

ALWAYS A BETTER WAY . .

MINERALS & CHEMICALS CORPORATION OF AMERICA
Dept. W, 210 W. Washington Square, Philadelphia 5, Pa.

☐ Please send me "Preparation of Petroleum Feeds For Platinum Catalysts"

☐ I'd like to talk to a representative about a specific feed stock problem.

name _____ title _____

company _____

address _____

city _____ zone _____ state _____

Bingham

"KOKE-KRUSHER" HOT OIL PUMP

NON-CLOGGING!

PULVERIZES LARGE PIECES OF ENTRAINED COKE IN PUMPAGE

Bingham Type CKM
"Double Volute", Two Stage,
"KOKE-KRUSHER" for handling
hot, coke-laden pumpage at high heads.

CRUSHES COKE INSTANTLY

Positive crushing mechanism instantly crushes large pieces of hard coke entrained with the pumpage.

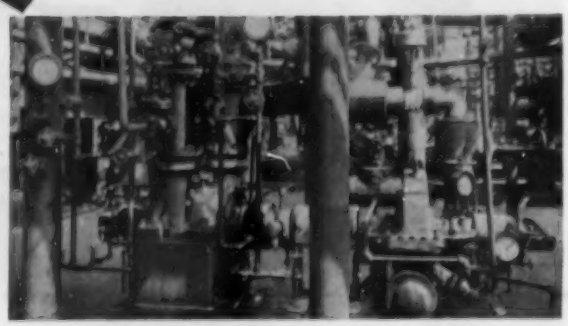
- Results in more hours on stream—less down time.
- The pulverizing action on entrained solids reduces clogging of other system equipment.
- Non-pulsating flow eliminates need of auxiliary equipment for control of pressure and/or capacity.
- Eliminates expensive protective devices.
- Smooth pump characteristics eliminate destructive vibration.
- Lower maintenance. Only one moving part.

HANDLES COKE-LADEN HOT OIL IN CRACKING SYSTEMS WITHOUT CLOGGING

The Bingham "Koke-Krusher", the only pump that crushes coke, is a field-proven, centrifugal pump specially designed for the severe services of pumping oil products such as *Residuum, Flash Tower Bottoms, Black Oil Recycle*—in which the oil carries in suspension pieces of hard coke of irregular size and shape.

This revolutionary Bingham pump features a coke crushing mechanism located in the suction chamber immediately in front of the impeller eye. Any piece of solid coke entrained in the pumpage *must* pass through the crusher, where it is instantly pulverized, before entering the impeller.

The resulting pulverized coke particles are small enough to assure free flow through the pump and all system equipment. The Bingham "Koke-Krusher" will make a big difference in your operations. Call your nearest Bingham office for full details.



Bingham "Koke-Krusher" pumping flash tar bottoms in pressure coke still of a large midwest refinery.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: 2800 N.W. Front Avenue, Portland 10, Oregon

Factories: Portland, Ore. • Vancouver, B.C., Canada

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TORONTO, ONT., CAN.
VANCOUVER, B.C., CAN.

IS YOUR PROBLEM...

ACIDS?
CORROSIVES? PRESSURES?
TEMPERATURES? OXIDATION?

National Tube has the answer

Check over the list of analyses shown here. Then, before you decide on new piping or tubing, get in touch with our engineers. They'll make certain you get the analysis that will insure the utmost in efficiency and economy. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

HERE ARE OUR 25 DIFFERENT STEEL TUBE ANALYSES:

Carbon	5 Cr, 1 Mo
Carbon, ½ Mo	9 Cr, 1 Mo
½ Cr, ½ Mo	12 Cr
1 Cr, ½ Mo	12 Cr, Al
1¼ Cr, ½ Mo	17 Cr
2 Cr, ½ Mo	18-8
2¼ Cr, 1 Mo	18-8 Ti
2½ Cr, ½ Mo, ¾ Si	18-8 Cb
3 Cr, 1 Mo	18-8 Mo
5 Cr, ½ Mo	25-20
5 Cr, ½ Mo, 1½ Si	3½ Ni
7 Cr, ½ Mo	5 Ni
8 Cr, ½ Mo	

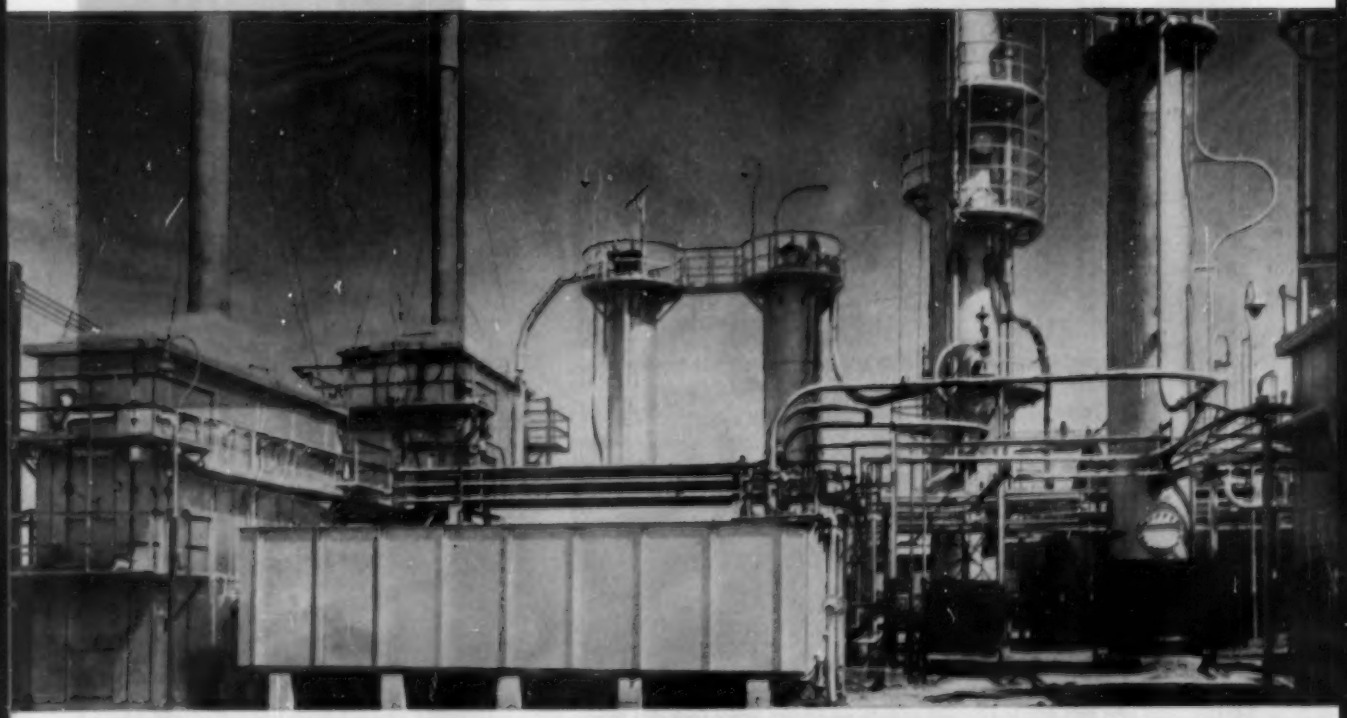
• Over the past 60 years, National Tube has made a thorough study of refinery tubing problems. The result of this study is an extensive collection of case histories covering virtually every tubing problem in the book. We call this collection our "experience file." With it, we are able to solve *your* refinery tubing problems.

Using this 60-year "experience file" as a basis, National Tube has developed 25 different steel tube analyses, each for the purpose of combatting specific refinery conditions such as exposure, pressure, temperature, oxidation, etc. Every one of these analyses has been tested and retested in refinery service, so that we know exactly what can be expected of each one. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are presently under study.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

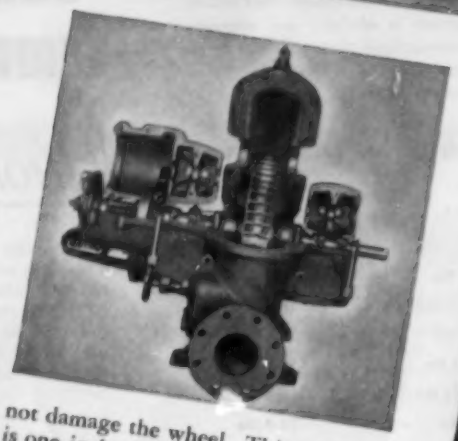
USS **NATIONAL SEAMLESS PIPE AND TUBES**



UNITED STATES STEEL

TERRY

LARGE CLEARANCES take the "worry" out of Turbine Operation

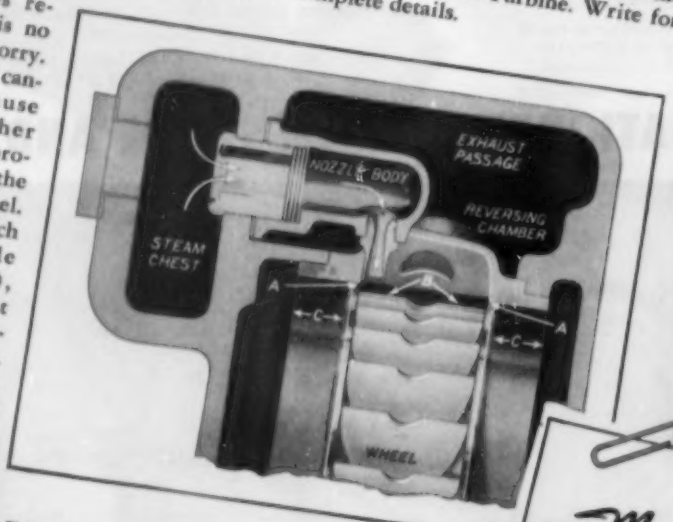


In a Terry Solid-wheel Turbine the power-producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets. This unique design permits unusually large blade clearance—see B in the diagram.

Even if this clearance becomes reduced, there is no real cause for worry. The blades still cannot foul because they are further protected by projecting rims at the sides of the wheel. These rims, which also have ample clearances (AA), will take without damage any rubbing that may occur.

Side clearance, CC, is so large that end-play from external thrust will not damage the wheel. This clearance is one inch or even greater.

Large side and blade clearances are only two of the many features of the Terry Solid-wheel Turbine. Write for complete details.



THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1191

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

It's Quality Deserves Consideration

FISHER®

LEVEL-TROL®

UPPER and LOWER SIDE CONNECTIONS

TOP and LOWER SIDE CONNECTIONS

UPPER SIDE AND BOTTOM CONNECTIONS

Factory calibrating or zeroing adjustment produces a correct 3 to 15 pound signal output for full float range operation, as particularly required in liquid level indication. Output signal of controller is linear as related to level height change.

Simple level adjustment indicating dial.

Pneumatic proportional band and specific gravity adjustment combined in one member.

Small compact relay unit, minimum working parts.

★ All welds are in accordance with ASME code for unfired pressure vessels.

Universally Accepted for

- LIQUID LEVEL CONTROL
- LIQUID LEVEL INDICATION
- INTER FACE CONTROL

Engineered for peak performance the Fisher Series 2500 Level-Trol is designed to give rugged, trouble-free service. It is high in sensitivity and accuracy . . . it is versatile in handling all kinds of liquids, with minimum service attention.

Fisher Bulletin F-3 gives full details . . . write for your copy today!

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER Since 1880

How A. O. Smith
Texas polymerization
REACTORS, HEAT
METALLURGICAL
VESSELS

THIS installation shows that A. O. Smith service extends far beyond the usual supplying of vessels and exchangers to order. Here, our metallurgical research served to prescribe the chemical specifications used by the customer to improve the corrosion-resistance of specific reactor linings.

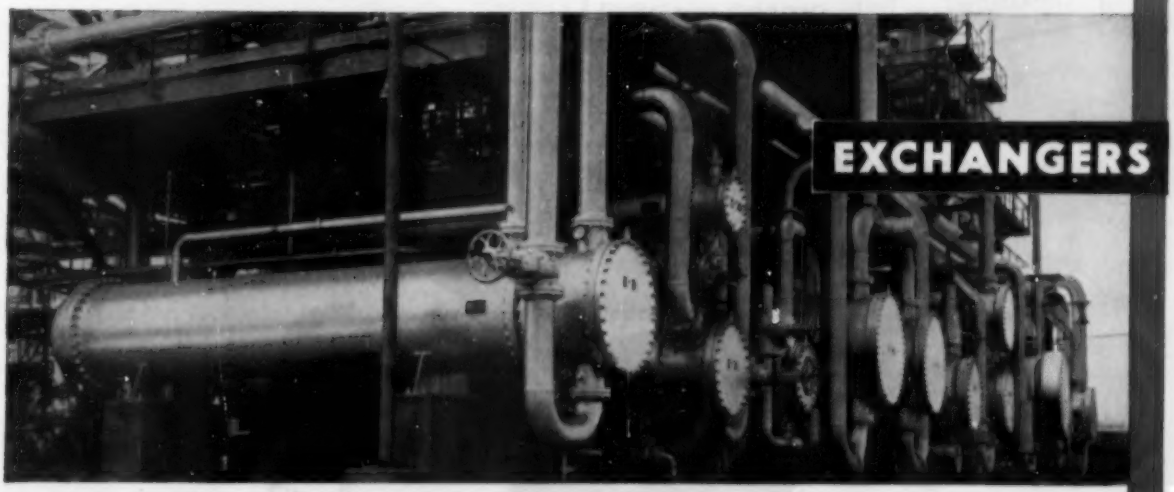
A. O. Smith supplied special pressure vessels, as well as five different kinds of heat exchangers for the phosphoric acid polymerization unit.

This typical example shows why the petroleum, petro-chemical and chemical industries bring their pressure vessel and heat exchanger problems to A. O. Smith.

Investigate A. O. Smith's performance in terms of your own processing needs. Write our nearest office. We'll be glad to give you detailed information about A. O. Smith pressure vessels and heat exchangers, engineering and research.

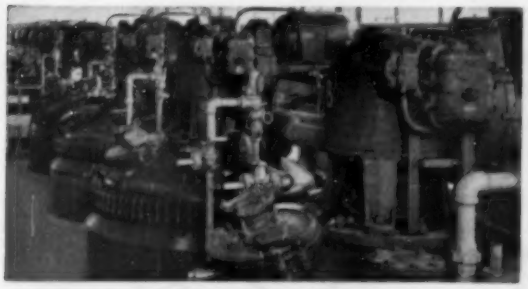
serves refineries

unit uses EXCHANGERS AND RESEARCH



Three A. O. Smith reactors with type 316 ELC lining are the heart of the unit. Designed for operating pressures of 640 psi, the vessels have 102-in. ID . . . are 58 ft. long with 2⅜ in. wall thickness.

The unit has 21 A. O. Smith heat exchangers. These include reboilers, condensers, coolers, heaters and exchangers, ranging in diameter from 15 to 51 in. We make all types of heat exchangers required by a petroleum refinery.



Broader service through Glascote—For more than 20 years, our subsidiary, Glascote Products, Inc., Cleveland, has been serving the process industries. Glascote can supply you with corrosion-resistant laboratory and pilot plant reactors . . . single-shell or jacketed storage tanks . . . double-jacketed condensers . . . columns.

Through research . . . a better way

A.O. Smith
CORPORATION

MILWAUKEE • HOUSTON • LOS ANGELES

Glascote Products, Inc., Cleveland, Ohio
International Division: Milwaukee 1

For more data on advertised products, use Readers' Service Cards, last page.

WHEN YOU'RE UP IN THE AIR

OVER PROCESS EQUIPMENT...

THE ANSWER IS

KELLOGG-ENGINEERED

FABRICATION

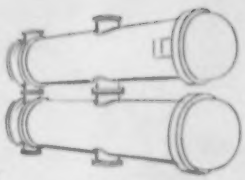
We emphasize "engineered" because M. W. Kellogg means much more than just putting together heat exchangers, pressure vessels, piping and other process equipment. Backed by a complete metallurgical and welding research staff, Kellogg process equipment is designed and fabricated by men who are recognized authorities in the field of heat transfer, stress analysis, welding techniques, non-destructive testing—and who constantly keep up with what is happening for tomorrow.

You can save many precious man-hours for your own engineers with Kellogg-engineered process equipment. You can assign the design problem to Kellogg or have Kellogg review your own design engineering to assure an optimum design. Your engineers will find it stimulating and profitable to work with the Kellogg staff.

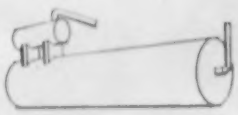
Kellogg process equipment means top performance at minimum investment and prompt deliveries. It is engineered for the job by engineers who *know* their jobs. If recently you have not had firsthand experience with the Kellogg Fabricated Products Division, we would welcome the opportunity to describe our expanded services and manufacturing facilities.

FABRICATED PRODUCTS DIVISION
THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.
In Canada: The Canadian Kellogg Company, Limited, Toronto
In Europe: Kellogg International Corporation, London
SUBSIDIARIES OF PULLMAN INCORPORATED

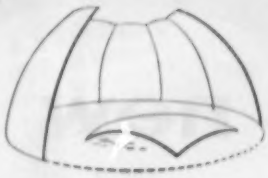
GET IT RIGHT FROM KELLOGG



HEAT TRANSFER EQUIPMENT

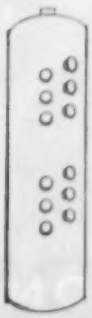


TANKS AND REACTORS



KNOCKDOWN VESSELS

PROCESS PIPING



PRESSURE VESSELS

For more data on advertised products, use Readers' Service Cards, last page.

BONNEY
WELDOLETS · THREDOLETS
new
1955
catalog
WELDOLETS
THREDOLETS
SOCKET WELDOLETS
. . . illustrating when and where to use them. Specific areas of application shown, also correct installation procedure and featuring these new developments:
1 Reduced inventory—size consolidation for interchangeability. 2 Thredolet rating addition—3000# and 6000#. 3 Complete range of stainless, alloy and non-ferrous materials. 4 Curvatures for additional pipe sizes through 36" and for caps, heads and flat surfaces. 5 New marking standard. 6 Weldolet Split Tees for complete encirclement reinforcement.
The new 1955 Bonney catalog will be mailed to you promptly upon request.
WELDING
FITTINGS
DIVISION
BONNEY FORGE & TOOL WORKS
721 MEADOW STREET, ALLENTOWN, PA.

Hold on there!... there's a better way!

YOU CAN NOW DISPOSE OF YOUR SLUDGE SULPHURIC ACID BY SHIPPING IT BACK TO CONSOLIDATED FOR REGENERATION

Two unique sludge acid regeneration units at Houston and Baytown, Texas, were recently put on stream by Consolidated's Southern Division.

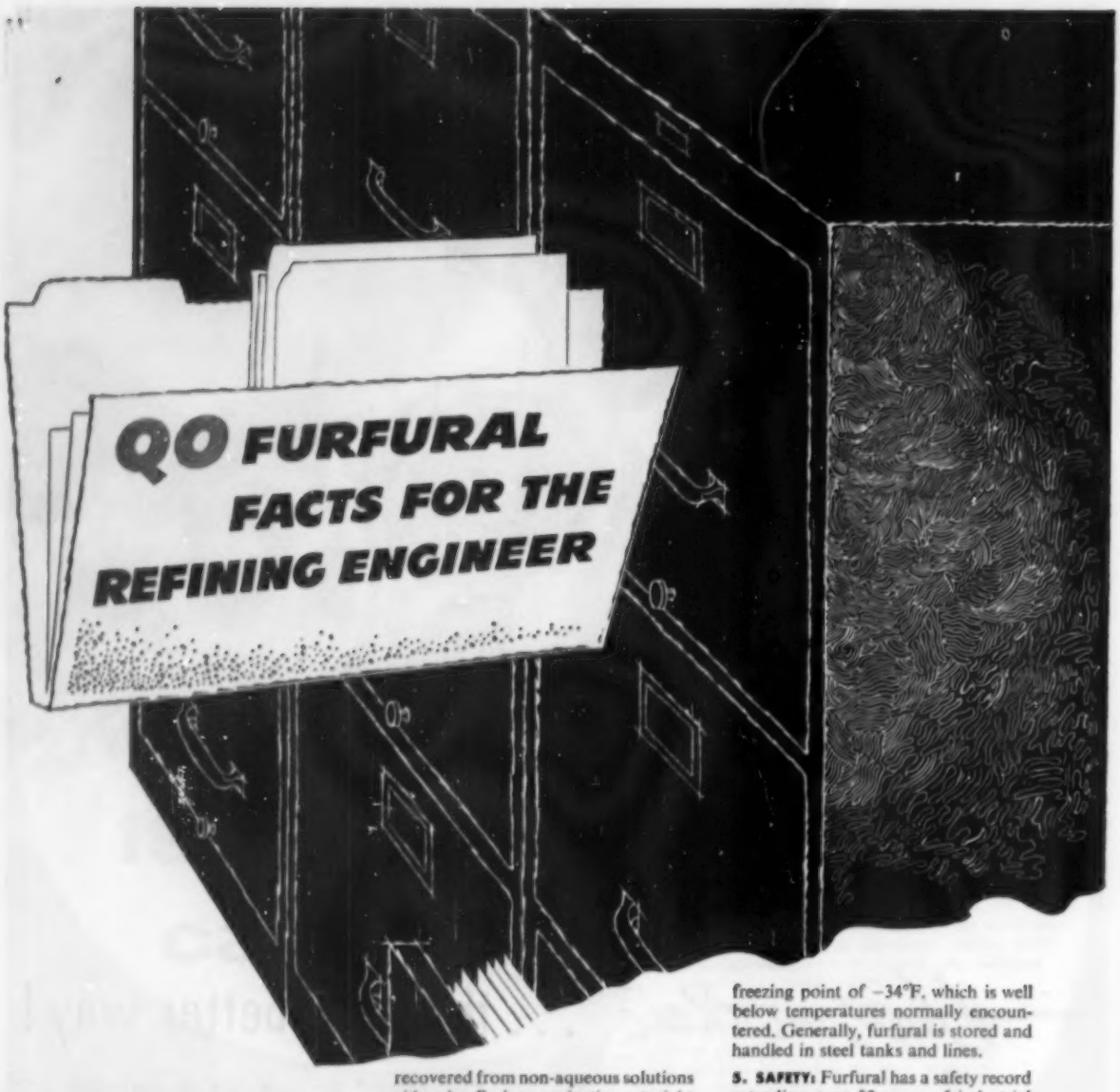
The new facilities will convert into new white sulphuric acid any grade of sludge—providing only that it can be pumped from the tank car or barge.

This new Consolidated service relieves petrochemical plant managers of the expense and bother of disposing of sludge by other means. Furthermore, it completely eliminates the danger of air and stream pollution.

Talk to the Consolidated man about your sludge acid problems. He can help you.

CONSOLIDATED CHEMICAL INDUSTRIES INC.

640 ESPERSON BUILDING • HOUSTON 2, TEXAS 380 MADISON AVE. • NEW YORK 17, NEW YORK



What Makes Furfural So Good As a Selective Solvent?

1. SELECTIVITY: Furfural is highly selective; it is a polar molecule and gives a sharp separation. Its high specific gravity permits rapid phase separation.

2. EASE OF RECOVERY: Furfural may be readily recovered from aqueous solution by steam stripping; it may be recovered from non-aqueous solutions either by flash vaporization, straight distillation, steam stripping, or extraction with water.

3. STABILITY: Under the conditions encountered in refining, furfural has a high degree of stability, as shown by the low solvent losses in operating plants around the world.

4. STORAGE: It is not necessary to use special handling precautions for cold weather operation since furfural has a freezing point of −34°F. which is well below temperatures normally encountered. Generally, furfural is stored and handled in steel tanks and lines.

5. SAFETY: Furfural has a safety record extending over 30 years of industrial use. It has a high flash point (150-160°F.), and a vapor pressure of 8 mm. Hg at 39.9°C.

6. COST: Furfural is low in price, and with high recovery, overall solvent costs are attractively low.

7. AVAILABILITY: Large quantities of furfural are produced the year around at three plants from raw materials which are replaceable yearly.

If you would like to know more about the properties of furfural, write for our Bulletin 203 "Physical Data on Furfural."

The Quaker Oats Company **CHEMICALS DEPT.**

340J The Merchandise Mart, Chicago 54, Illinois
Room 340J, 120 Wall St., New York 5, N. Y.
Room 410J, P. O. Box 4376, Portland 8, Oregon

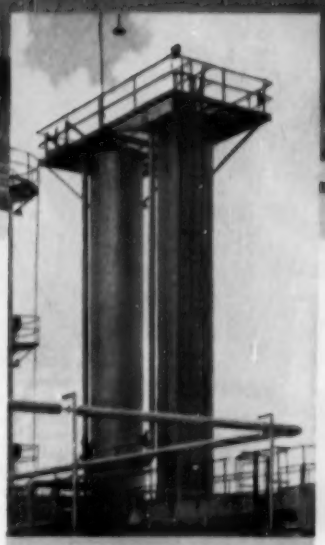
In the United Kingdom: Imperial Chemical Industries Ltd., Billingham, England • **In Europe:** Quaker Oats-Graanproducten N.V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Oto", Copenhagen, S. Denmark
In Australia: Swift & Company, Pty., Ltd., Sydney • **In Japan:** F. Kanematsu & Company Ltd., Tokyo

Does your process call for *drying?*

Reynolds Activated Alumina Removes 12,500 Gallons of Water Per Hour in Operation of Supersonic Tunnel

At Lewis Flight Propulsion Laboratory, Cleveland, the 10x10 foot Supersonic Tunnel above has a design capacity of 1,440,000 cfm. Low cost Reynolds Activated Alumina is used in six large beds totaling 25,000 square feet to reduce this volume of air to a dew point of —40° F. (Inlet conditions; 85° F dry bulb, 78° F wet bulb, 68° F dew point.) In some applications, Reynolds Activated Alumina will adsorb up to 22% of its weight. It can be regenerated repeatedly by heating with little loss of efficiency.

Reynolds regional offices offer you the service of staff engineers and other specialists in the use of aluminum chemicals, shipping containers and mill products. For your copy of Free Brochure "Reynolds Aluminum Chemicals", write *Reynolds Metals Company, P.O. Box 1800-CT, Louisville 1, Kentucky.*



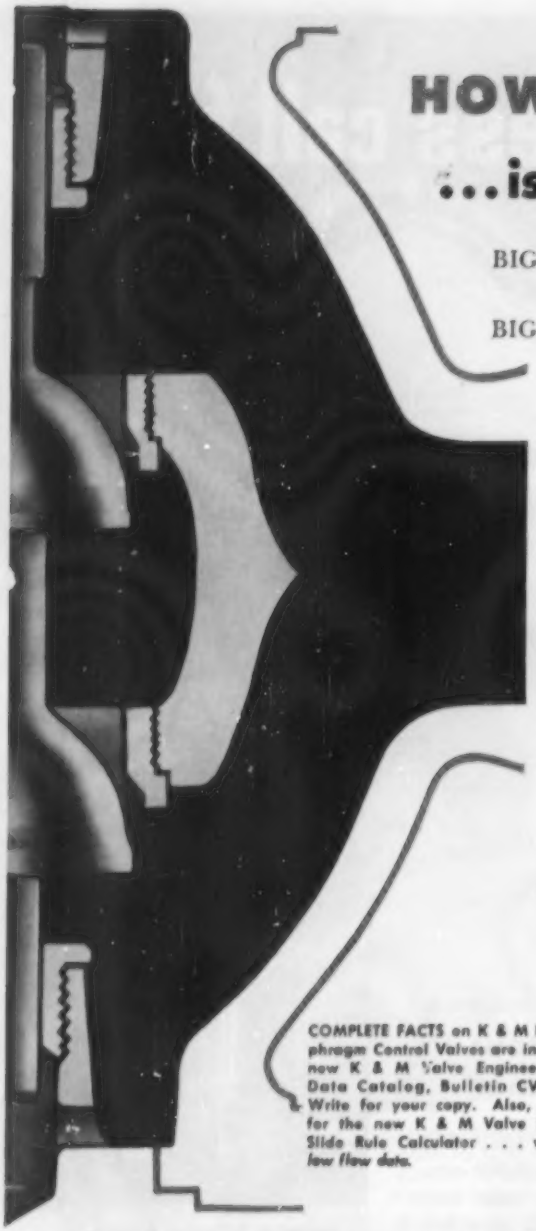
Reynolds Activated Alumina Used in HF Alkylation at Texas City Refining

The use of Reynolds Activated Alumina at Texas City Refining Inc. reflects the high suitability of this material for drying of hydrocarbon feeds in many processes such as HF alkylation.

Reynolds Activated Alumina in these processes provides elimination of silica migration, better fluoride removal and thorough drying of alkylate while in process.

REYNOLDS CHEMICALS

BY THE MAKERS OF REYNOLDS ALUMINUM



HOW BIG

...is a K & M six-inch valve?

BIG enough to pass 500 gpm of cold water through the valve body at a constant drop of one pound pressure.

BIG enough to provide the largest flow coefficient available in a standard six-inch diaphragm control valve.

Body flow passages of all K & M valves, for example, actually average 140% of cross-sectional pipe area. There's more space for fluid to flow . . . smoothly, freely and without turbulence. Frequently a smaller nominal size K & M Valve provides sufficient capacity to satisfy requirements that formerly called for a larger, more expensive valve.

Inner valve open areas, on the other hand, average only 80% of cross-sectional pipe area. Therefore, flow restrictions occur principally across the inner valve . . . where the restriction is controllable throughout the entire range of valve stem travel.

This K & M design often permits lower initial costs . . . always contributes to more precise flow regulation through the K & M Inner Valve.

COMPLETE FACTS on K & M Diaphragm Control Valves are in the new K & M Valve Engineering Data Catalog, Bulletin CV53. Write for your copy. Also, ask for the new K & M Valve Size Slide Rule Calculator . . . with *low flow data.*

C_V COMPARISON TABLE

Valve Size	K & M	Valve B	Valve C
¾"	10.9	8.4	8
1"	17.3	14.9	12
1½"	39.1	33.2	28
2"	61	57	48
2½"	97.7	71.0	72
3"	150	116	100
4"	219	197	165
6"	500	364	360

Based on the maximum C_V at rated travel through the valve body. From manufacturers most recent slide rules or tables.

diaphragm control valves

K&M

Valve Makers Since 1879

KIELEY & MUELLER, INC.

64 Genung Street
Middletown, New York

Now... your own painter can "COLD-GALVANIZE" any steel surface with

DIMETCOTE

* the 100% inorganic zinc coating

any PLACE

any TIME

any WHERE

SPRAY or BRUSH

Dimetcote is absolutely unique. It is not a paint, it contains no oils, resins or any other organic materials, yet it can be applied by spray or brush. When Dimetcote is applied to steel, a reaction takes place at the surface which produces chemical bonding as well as physical adhesion. It is almost impossible to find the interface between Dimetcote and the steel.

Dimetcote has many unusual characteristics. It shows no visible change after more than ten years exposure to the most severe weather conditions – sun, heat, fresh and salt water. It is insoluble in all solvents and petroleum products. It is highly abrasion resistant, but if abraded through to bare steel, the coating will cathodically inhibit corrosion.

Now tanks and structures can be given the same protection that galvanizing affords, *plus salt water resistance.* Existing structures need not be dismantled and new structures can be coated either before or after erection. *Only one coat* of Dimetcote over a sandblasted surface is required to protect such structures as:

Tank Exteriors • Cargo Tanks in Tankers • Dam Gates • Structural Steel • Christmas Trees • Buoys • Floating Roof Tanks • Offshore Rigs • Water Tanks • Barges • Ship Decks • Stacks

Write for the Dimetcote Technical Bulletin today.

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Rockwell-Nordstrom Valves Prove Lubrication Is The Cheapest Maintenance!

● LUBRICATION ELIMINATES METAL-TO-METAL FRICTION

—the major source of valve wear. As in your automobile engine, lubrication assures longer life and better performance. Pressurized lubricant also forms a remarkably leakproof seal between the plug and the valve body. This lubricant seal has proven far more effective than the uncertain metal-to-metal seal in ordinary valves where a tiny scratch means leakage . . . and eventually, expensive reseating.

Costly valve down time is practically eliminated with Rockwell-Nordstrom valves because lubrication stops trouble before it starts. The lubricant also hydraulically jacks the plug to eliminate stuck or jammed valves, assures *instant*, quarter turn operation.

● LUBRICATION IS FAST...EASY

Rockwell-Nordstrom valves can be lubricated either with a pressure gun directly through the standard Rockwell fitting or by unscrewing the fitting and inserting lubricant "sticks." Lubrication never requires valve down time because any Rockwell-Nordstrom valve can be lubricated under service pressure.

Like any lubricated mechanism, frequency of use and operating conditions are the determining factors in the lubrication schedule. In any case, the time it takes to lubricate a Rockwell-Nordstrom valve is an investment in trouble-free, long-life valve service.

● LUBRICATION PENNIES SAVE MAINTENANCE DOLLARS

A few cents worth of lubricant buys three things: 1. *new seats* (renewing the lubricant is like reseating an ordinary valve) . . . 2. *smooth, dependable operation* and . . . 3. *savings* in terms of lower repair, replacement and down time expenses. It is not the cost of the lubricant that is important, but the *savings* through longer, more dependable life of the working parts and better performance.

● GENUINE ROCKWELL-NORDSTROM LUBRICANTS

are specially compounded to not only reduce friction, but also to create a positive, leakproof seal. They are the result of 40 years of production "know-how" and field testing by the pioneer lubricated plug valve manufacturer. Their sole purpose is to insure that Rockwell-Nordstrom valves give you the best valve service you've ever had. That's why it's good business to use *only* genuine Rockwell-Nordstrom lubricants in Rockwell-Nordstrom valves.

● 40 YEARS OF PERFORMANCE PROVE

that Rockwell-Nordstrom valves are the most economical valves you can buy for *any* service. Over the years, the sale of repair parts has been less than one-half of one per cent of Rockwell-Nordstrom valve total valve sales . . . *for every two dollars users spend on Rockwell-Nordstrom valves, they spend less than one penny for repairs.*

Whatever your needs, there is a Rockwell-Nordstrom valve that will do the job with more trouble-free dependability and at lower cost per year than any other valve you've ever used. And the first cost of Rockwell-Nordstrom valves is no more (and often less) than the cost of ordinary valves! For more information, write: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

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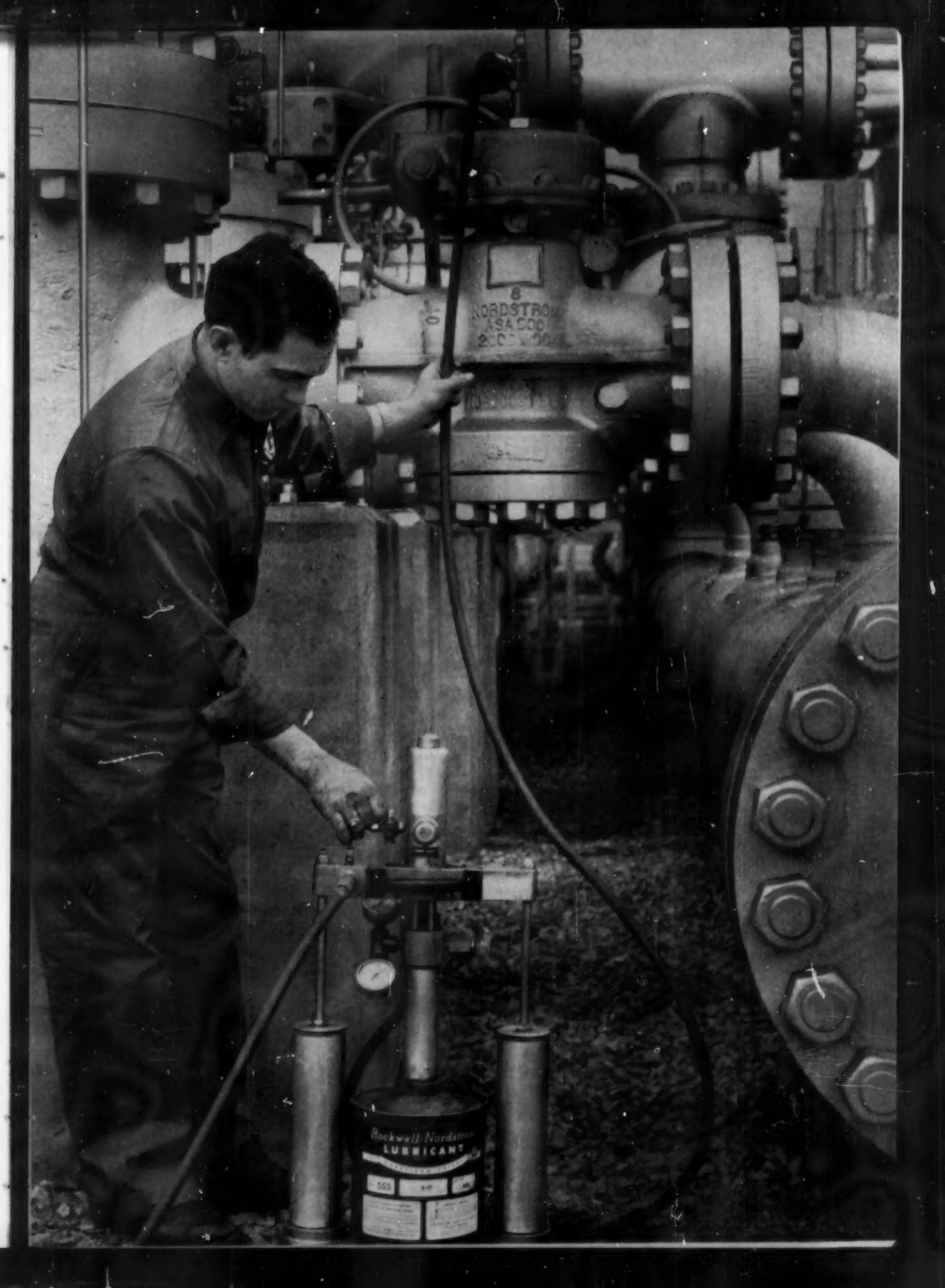
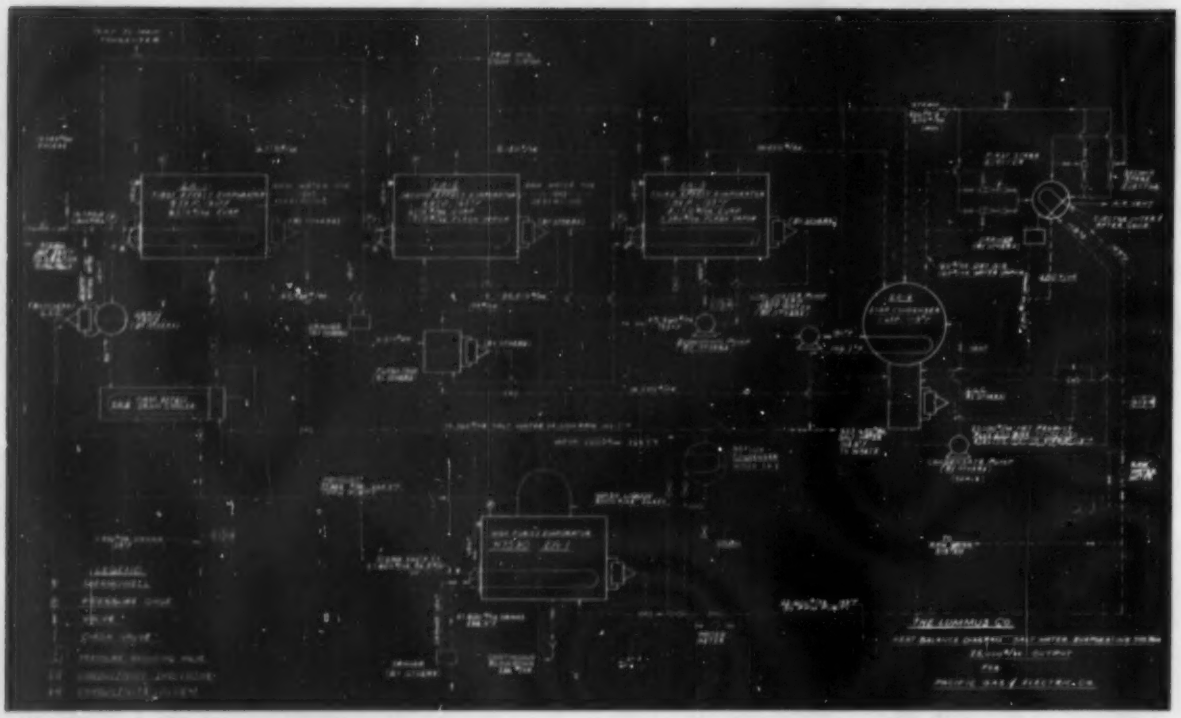

Rockwell-Nordstrom
LUBRICANT



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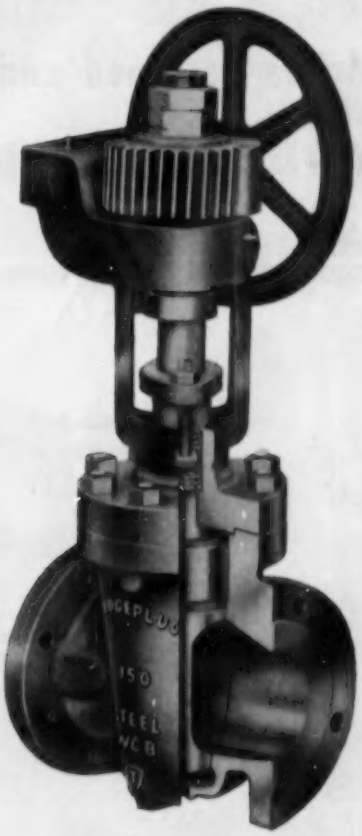

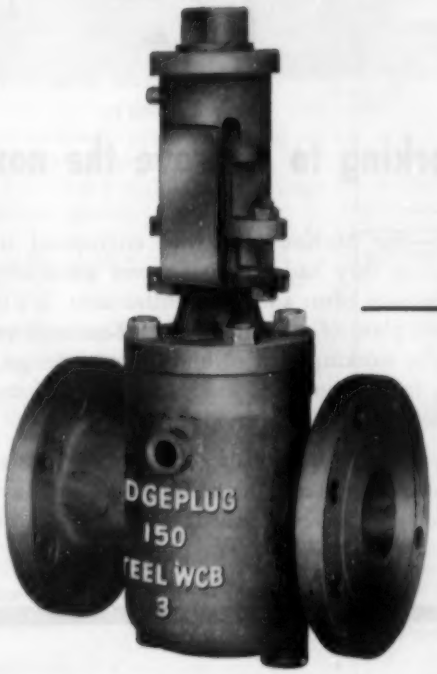

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For Special Services—handling products that will harden or congeal at ordinary temperatures, such as: asphalt, pitch, petroleum residue, tar, resins, vegetable and animal fats, soap, sulphur, etc.—Wedgeplug Valves can be supplied Steam-Jacketed.

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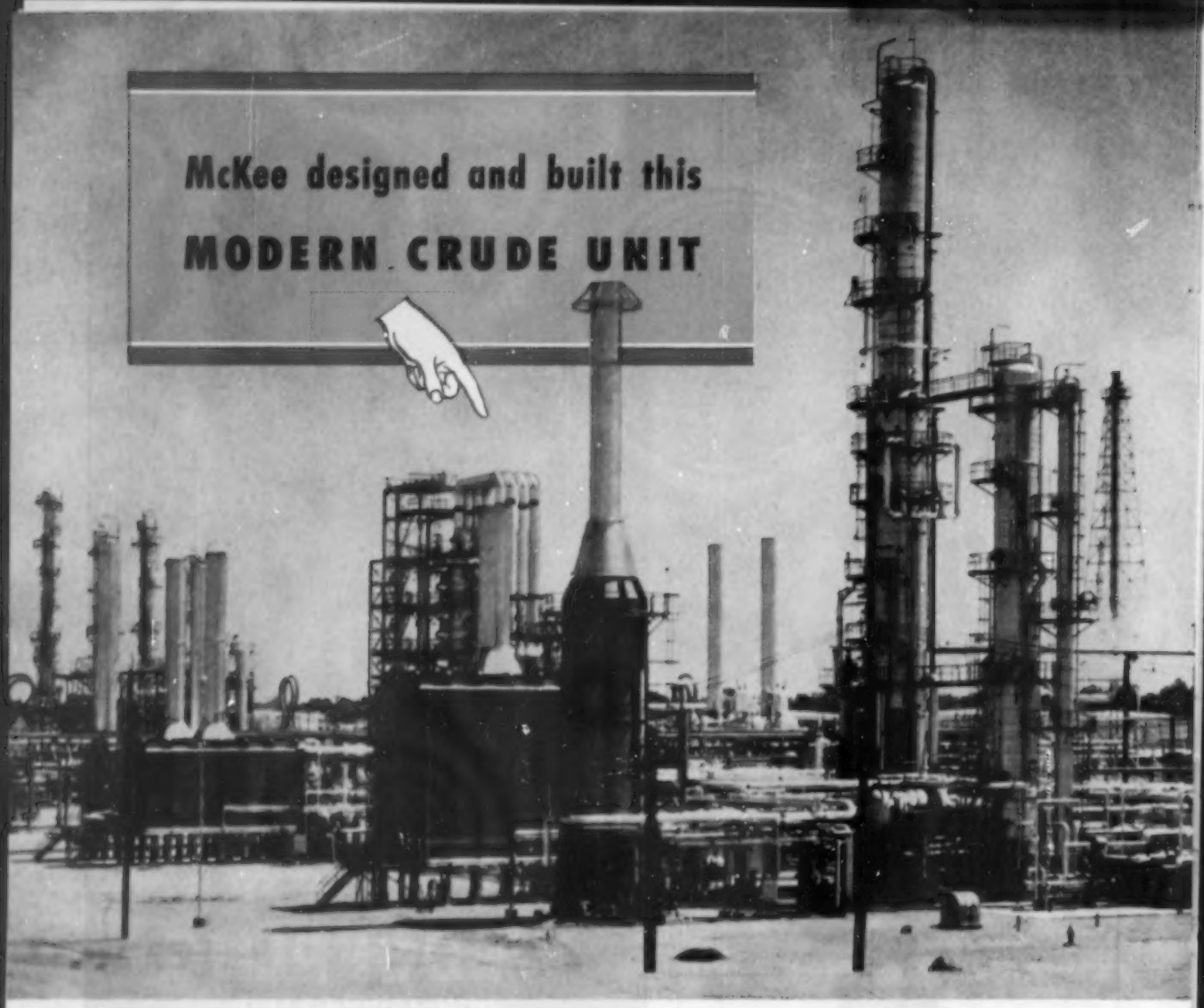

...but McKee engineers are already working to improve the next

MAKE no mistake—the McKee men who engineered this plant put everything they had into it—expert knowledge, long experience, conscientious effort and great enthusiasm. It's the most modern and efficient plant of its kind—but McKee engineers are never satisfied. They're working now to find a better design, a more efficient layout, a faster, more economical method of construction for the next project.

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To The Editor:

The PETROLEUM REFINER of last November carried an article "New Alloys for Multi-Layer Vessels" and therein the writer referred to a paper "Multi-Layer Construction of Thick Wall Pressure Vessels" by T. M. Jasper and C. M. Scudder "which was taken from the 1941 Transactions of the ASCE."

Some of our friends abroad were anxious to obtain the above paper and we contacted the ASCE but after investigation we were told that no article ever was published under such a title by the above-named authors and it could only have been a paper presented at some meeting but never published.

We would greatly appreciate your help in locating the paper in question.

E. A. Henault, Inc.
New York, May 10, 1955

Editor's Note: *The author of the article in question, G. E. Fratcher, who is director of engineering, Tubular and Process Equipment Division of A. O. Smith Corporation, advises that "the reference to the ASCE is in error and should be the AIChE, which is the American Institute of Chemical Engineers."*

"Head and Shoulders"

I feel your magazine is head and shoulders above the others in the petroleum field. There is hardly an issue that I don't cut out and save at least one or two articles.

D. D. MacLaren
Scotch Plains, N. J.

Very Prompt Reaction

Many thanks for your letter and your excellent presentation of our article on heat exchanger design. I appreciated the extra issues and the tear sheets you sent.

You will be interested to know that a sizable number of requests for additional copies of the articles have come in. We were surprised at the very prompt reaction.

E. D. Anderson
Chief Engineer
Western Supply Company,
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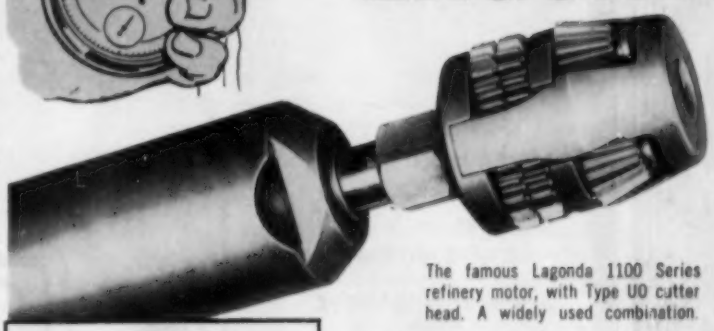
When minutes mean money ...TRY LAGONDA



The famous Lagonda 1100 Series refinery motor, with Type UO cutter head. A widely used combination.

For tubes of wide tolerance — the Long-Surface Swing Frame head.

For tough, uneven coke — the Type H-2 head.

FOR CONDENSERS AND HEAT EXCHANGERS

Direct-drive air-driven cleaner using shaft and drill heads, the motor supported outside the tube by overhead pipe. Motor has trigger control. Also available with electric motor.

Cases are constantly occurring where a slow-moving clean-out has hit it up to a fast gallop when a Lagonda cleaner got going. Very often it is a matter of cutter head selection — but there's more to it than that. There's the irresistible power of the Lagonda 1100 Series refinery motor, armed with a Lagonda cutter head that has the stamina to turn that power into smashed and routed coke. It *takes* stamina, too, for the motor has thrust bearings both ways and unique front end lubrication to deliver all the torque the pressure can supply. Takes a Lagonda cutter head to handle all that power. When high-priced minutes are involved, try Lagonda. Get in touch with your near-by Lagonda man, or write Elliott Company, Lagonda Division, Springfield, Ohio.

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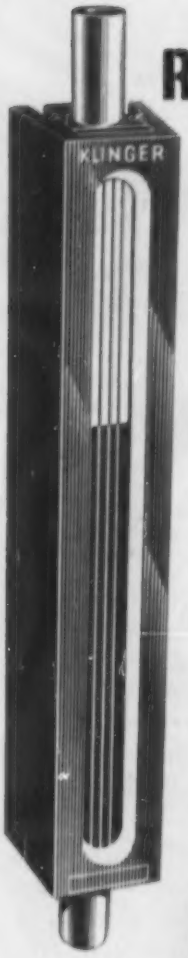

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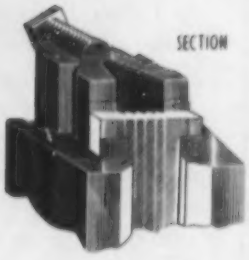
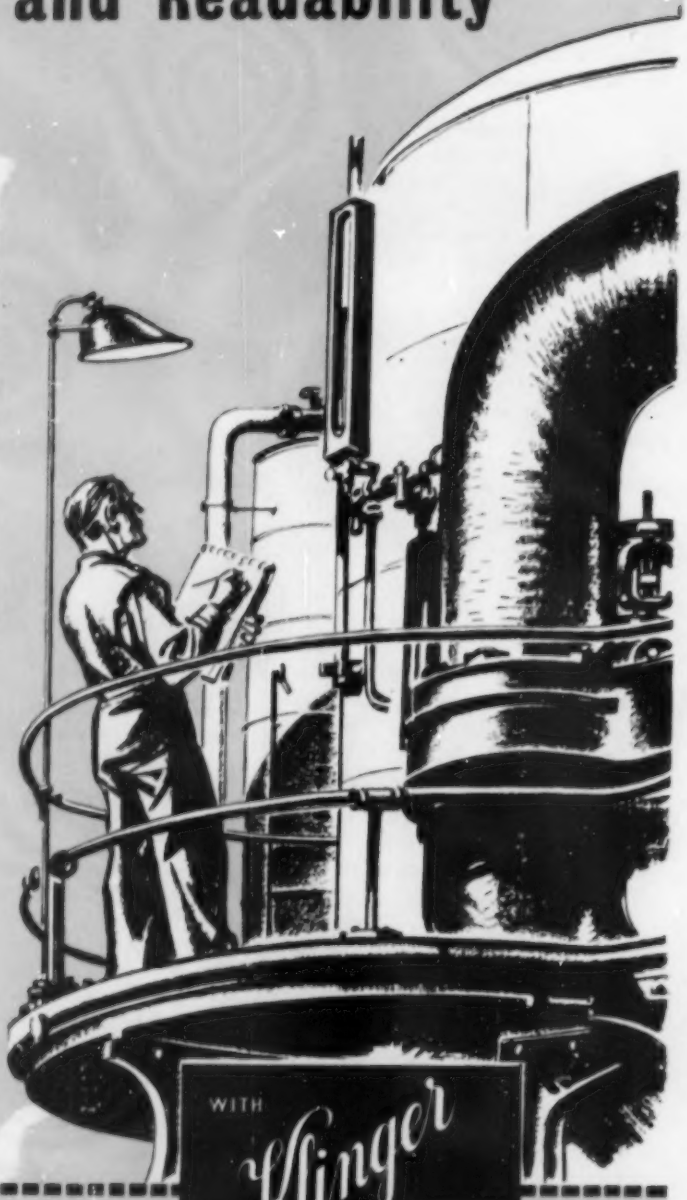
Gage body turnable, free to expand, and easily removed.



Write for the Klinger Master Catalog which describes the complete range of Klinger products.



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A Quick Look at the Industry THIS MONTH

Petroleum REFINER
June, 1955

Motor fuels will carry heavy share of new tax burdens being imposed by states. Eight governors have asked that motor fuel tax rates be upped. Even without new levies there would be a sizeable increase in these revenues because of growing motor vehicle travel. Motor vehicles used 43 billion gallons of fuel in 1953 and 44 billion in 1954, according to Bureau of Public Roads. Another 4 to 5 percent gain in 1955 gasoline sales is predicted by A. J. McIntosh, chief economist of Socony Mobil Oil Company.

New motor fuel taxes will be followed by others as inevitable result of long-time state and local spending sprees. 1954 outlays by these governing units was $27.5 billion. In first quarter of this year they were running at annual rate of $28.8 billion, and according to National Securities and Research Corporation, they will spurt to $30 billion for year as whole.

This gouge will be felt more keenly than in past years because of reversal of downward trend in federal government spending. After tumbling from peak output of more than $60 billion two years ago, U. S. government spending for past six months has been running at slightly more than $45 billion annual rate, and no further decline is likely.

-•-

New method of up-grading crude has been developed by Hungarian Professor J. Varga of Budapest Technical Academy. Hungarian crude with high asphalt and sulfur content yields low volumes of gasoline and kerosene when refined. Asphalt molecules are decomposed into lighter fractions and the crude is desulfurized by the injection of hydrogen at 60 to 70 atmospheres pressure. First industrial application of process was made last year, resulting in substantial increases in yields.

-•-

Government will probably get completely out of active participation in synthetic rubber business. Last of the copolymer plants, located at Baytown, Texas, which had only one bidder last year now has nine companies submitting bids. Last year's unsuccessful bid of $2,486,448 is sure to be topped this time.

Companies bidding are General Tire, American Resinous Chemicals, Baytown Rubber & Chemical, Food Machinery, Goodyear Rubber, Edwin W. Pauley, Minnesota Mining, Thiokol Chemical and United Carbon.

Purchase of plant by Food Machinery would give it two of the three necessary for completely integrated manufacture of GRS rubber.

-•-

Triple advantages of desulfurization, hydrogenation of unsaturated components, and effective utilization of high-value hydrogen make new hydrogen-treating processes very interesting to refiners.

Current investment in individual treating units in refineries today, however, makes justification of units for treating entire crude feed doubtful under existing conditions. This type unit may be the ultimate answer, but more likely short-range possibility is for the installation of hydrogen-treating units on specific streams.

Potential of these processes is enormous.

-•-

$300 million will be spent on atomic energy research by non-government organizations in the next four years, according to report prepared after year's study by Atomic Industrial Forum. This first survey of private atomic energy activities in U. S. declares:

- Between 3 and 5 million kilowatts of electric capacity must be built and

A Quick Look at the Industry (continued)

operated on uneconomic or break-even basis before reactor-generated electric power can become competitive with conventional power. Large reactor power plants will become economic after 1962.

- By 1963, manufacture of components for reactor plants will be $700 million-a-year business.
- By 1965, more than $7.5 billion will have been invested in U. S. on reactor construction.
- Also by 1965, atomic energy developments will call for total of 30,000 to 40,000 scientists and engineers.

-•-

Death of legislation directly curbing imports will intensify, not hush, clamor on subject. By empowering President to act when brought-in volume endangers national security, Congress is in effect inviting imports foes to watch sharper, protest louder in effort to prod Ike to action.

"Imports in quantity dangerous to national security" is amount awkward to convert into barrels, so independents will set teeth in recommendation by Cabinet Fuels Committee that foreign oil brought in not exceed 1954 ratio to domestic production.

Blast came last month from Independent Petroleum Association of America:

- U. S. bought 19 percent more foreign oil in February-March-April than in 1954 period.
- Imports will average 1.1 million barrels daily from May through July, up 9 percent over 1954 period.
- Domestic production will be reduced 400,000 barrels daily for May through September.

-•-

Imports will be factor in improved earnings of international companies in 1955, compared with remainder of industry, according to Standard & Poor's Industry Surveys. Other reasons: International companies will have benefit of sharper rise in demand outside U. S., and ". . . somewhat better profits of these companies within the U. S. should help . . ."

-•-

Rapid expansion of refining facilities in Pacific Northwest will continue; also concurrent increase in land leasing, geological and geophysical exploration and wildcat activity. Region includes some old sedimentary basins that will receive increasing attention. Continuing growth of oil economy in region is pointed up by recent completion of General Petroleum's Ferndale, Wash., refinery; Shell's refinery abuilding near Anacortes; and plans for third refinery, by another company, in Tacoma area.

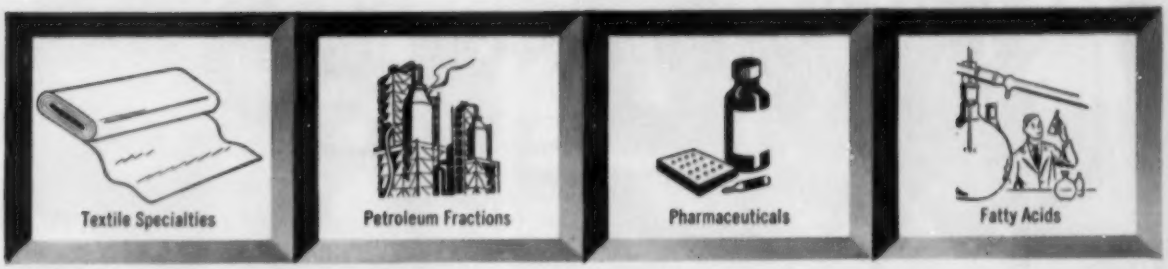
-•-

Refiners with excess available butane are taking another close look at alkylation. It provides an alternative route to top octanes. Some have started up isomerization units (shut down since World War II) to make isobutane feed.

-•-

Refinery work was again proved to be the safest in petroleum industry by API's latest Injury Experience report. During 1954, industry as whole experienced disabling injury rate of 7.97 for every million hours worked, while refineries held theirs to 5.29, which was lowest of any major oil or gas activity. Much encouragement comes from fact that refinery injury rate decreased 10.3 percent from 1953 experience and 24.7 percent from the 1952 rate. Industry enjoyed drops of 11.5 and 17.6 percent in similar comparison.

FOR SULFONATIONS SULFATIONS



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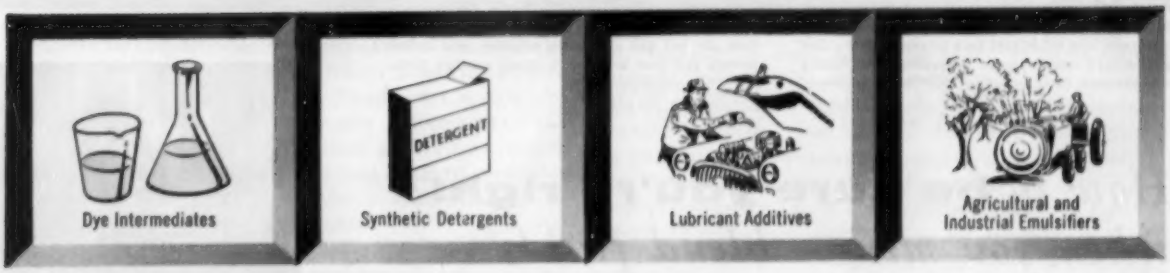

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You Improve Sulfonation Efficiency. SULFAN has 99.5% SO_3 available for sulfonation reactions. In many applications, this means considerable savings in operating costs because SULFAN offers nine times as much usable SO_3 as 100% sulfuric acid, and over three times as much as 20% oleum.

You Increase Batch Sizes. With SULFAN, there is no waste acid. This means larger batch sizes (or more rapid through-put) . . . often double without increasing size of equipment! Since no water is formed when SULFAN is used for sulfonation, the waste acid problem inherent with sulfuric acid or oleum is also eliminated.

Benefits of operating efficiency, ease of handling and waste acid elimination make SULFAN worth your prompt investigation. Write today for technical information. A letter outlining your specific needs will enable us to supply data of value to you. As always, information regarding your process will be held in strict confidence.

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ALLIED CHEMICAL & DYE CORPORATION

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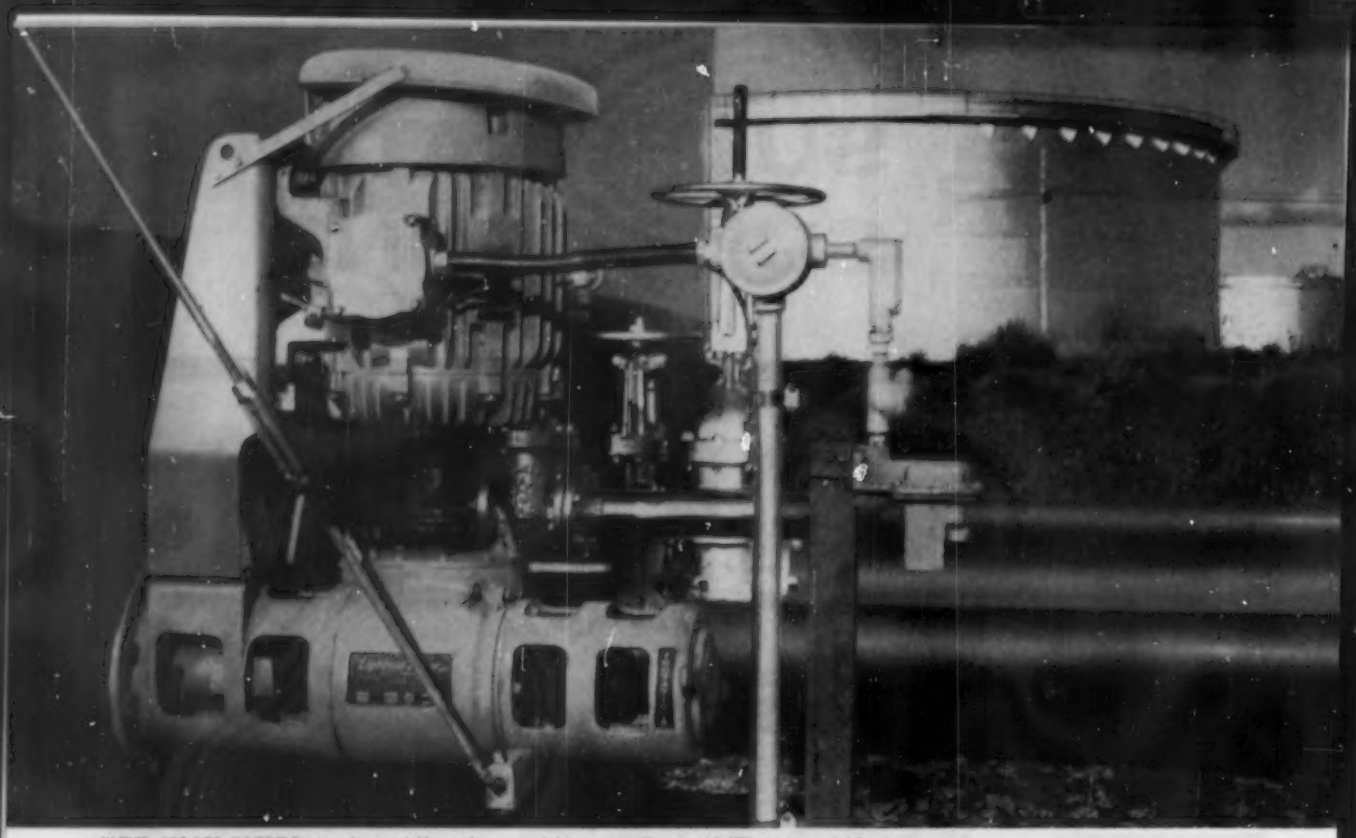

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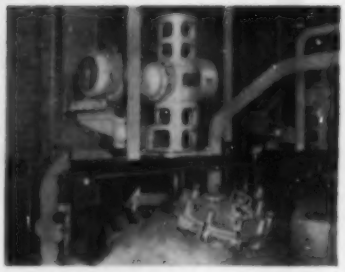

MIX ANY FLUIDS quickly, thoroughly, in open tanks or closed pressure vessels, with turbine-type LIGHTNIN Mixers. Standard sizes from 1 to 500 HP; hundreds of standard power-speed combinations.

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Private Industry Will Do It!

SALE OF THE synthetic rubber plants to private industry, which is virtually complete in all its phases, sounds a new note in this important phase of the American economy. Much speculation has resulted concerning the effect of this transfer. Several things seem apparent. Total capacity of the synthetic rubber industry will be expanded in the next five years. A number of important changes will occur within the individual plants as a result of the evaluation and execution of plans required to meet the challenge of competition.

Value of the Industry—Conceived and built during World War II, these plants served to supply rubber when it was unavailable from natural sources. They were of inestimable value during this crisis. Also, many American consumer dollars were saved when synthetic provided a brake on natural rubber prices in the post war period. Synthetic rubber plants are the most significant stabilizing influence ever injected into the rubber economy. Even so, natural rubber rose to over seventy cents per pound and was held to even this level only because synthetic was available during the same period for some 20-odd cents.

The new owners of these plants now have the prospect of using these plants to perform still another service for the American public. The world-wide rubber situation is such that present and future demands cannot be met by natural rubber supplies. Reliable estimates make the outlook for rubber shape up like this:

1955	
World-wide Rubber Demand	2,640,000 long tons
Natural Rubber Production	1,800,000 long tons
Synthetic Rubber Demand	840,000 long tons
1960	
World-wide Rubber Demand	3,200,000 long tons
Natural Rubber Production	1,800,000 long tons
Synthetic Rubber Demand	1,420,000 long tons

Many factors make it doubtful that natural rubber supplies can be increased during this same period to levels substantially above those at present. These figures, therefore, point to a considerable expansion in the next five years of synthetic facilities. Concurrent with the expansion in capacity will be changes dictated by economic considerations.

Expansion Plans — Announcements of construction plans are coming along very rapidly. Other plans, as yet unannounced, are under consideration. Here are some of the likely routes that will be taken in improving and expanding plants.

Butadiene plants

1. Conversion from butylene to normal butane feedstock.
2. Recovery and utilization of by-product hydrogen produced in the dehydrogenation reaction.
3. Recovery of some of the olefins resulting from cracking during dehydrogenation, such as ethylene and propylene.

Copolymer plants

1. Addition of cold rubber manufacturing facilities.
2. Conversion from batch to continuous operation.
3. Conversion or addition of units to make other products such as latex.

Operation of butadiene plants with butylene feedstock means only one dehydrogenation step. With normal butane feed, an additional dehydrogenation unit would be required. Currently only one of the large capacity butadiene plants utilizes butane feed. Butane is available in large quantities while butylenes are supplied only by the refineries who also have use for them as alkylation feed to help meet the increasing octane demands. Thus, some of the plants would gain a measure of independence in terms of their feedstock by converting. In new expansion to increase capacity, the processes for direct conversion of butane to butadiene in one stage may come in for consideration.

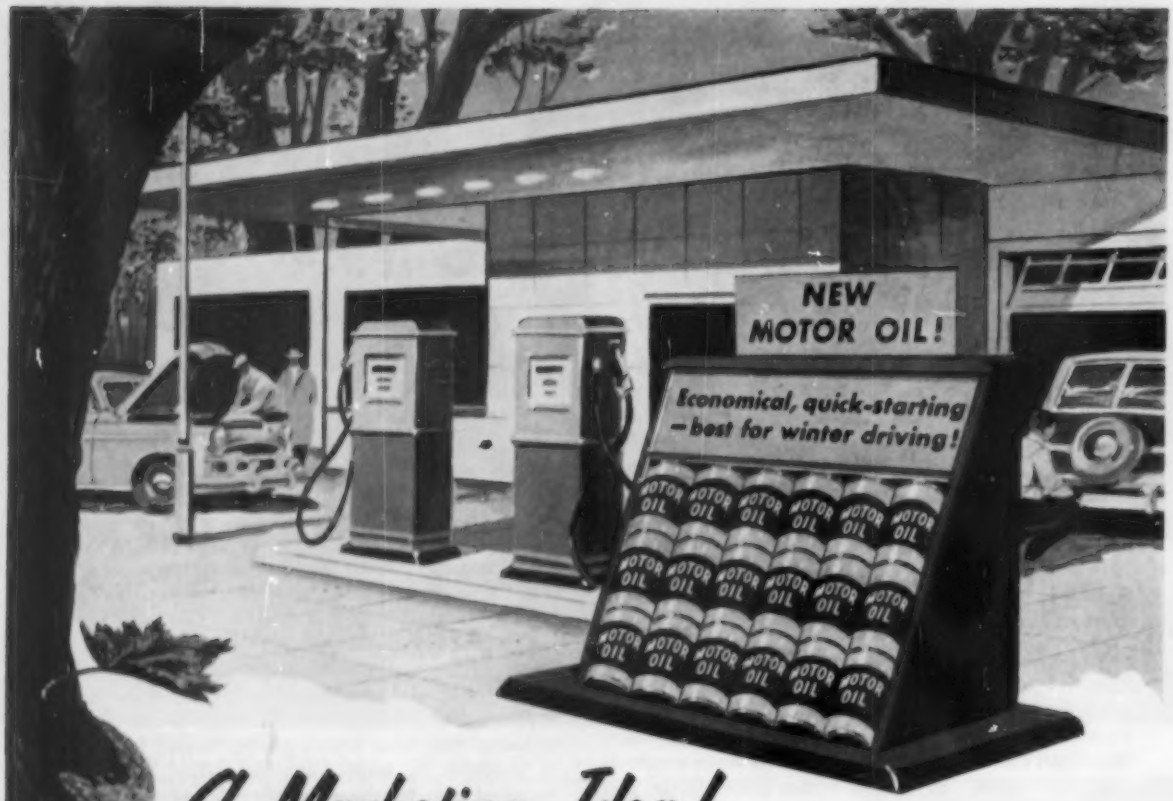
The off-gases from the dehydrogenation units contain quantities of hydrogen, ethylene and propylene. Currently these are being used as fuel and steps may be taken to make better use of these high value materials.

Conversion to cold rubber of about 87 percent of capacity of all copolymer plants in the program, excluding the standby Institute, W. Va., plant, had been made prior to plant sale. However, individual plants may be far below this figure while others are converted 100 percent. Those plants not converted will probably go to this type operation.

Only 50 percent of the copolymer plant capacity is continuous operation. The rest is batch operation. There will be activity in this field, also. Of course, individual plants may find it more practical in some cases to remain on a batch basis.

Demand for latex has been brisk lately with supplies of natural rubber latex falling short of demand. Consumption of such consumer items as foam rubber have made this a growing market for the synthetic producer. Synthetic latex capacity is currently around 6,000 long tons per month, but with demand at its present level, additional facilities are likely.

Under Private Ownership—Some of the plants have always produced lower cost products than others. This is due to geographical location, different proc-



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esses, and many other variables. Under government management, however, the same price existed for all butadiene, styrene and rubber produced. However, such a leveling out of individual plant product costs will no longer exist. The high-cost plants will have to stand on their own two feet through improved technology and facilities. Certainly, this factor of product cost was a major one in the determination of the value of the individual plants. Competition is now going to force the high-cost producer to spend additional funds to improve his position in the picture. Many of the required additions and modifications, however, are going to be a year or so away and he must do with what he has in the interim period.

In the case of the butadiene plants, announcements have been made of plans to utilize the highly reactive butadiene for the production of basic chemical intermediates. However, here is an industry which significantly enough speaks of production in terms of tons per year—not pounds. It seems highly unlikely that any new markets are in the immediate future which can compare with those provided by the rubber goods industry. So, the future growth of the butadiene business may be definitely hitched to growth in the rubber industry generally.

One of the most interesting aspects of the announcements being made by the new owners is the establishment of research facilities. This is interesting because here is an industry which has been isolated from the kind of aggressive, applied research found in conjunction with most privately operated companies. True, there have been many important research developments. But, there has not existed the keen intra-plant competition now in prospect.

The industry has a healthy future, and it is certain that the confidence expressed in the private enterprise system as evidenced by the plant transfers is not misplaced.

True and Loyal Friend Gone

DR. GUSTAV EGLOFF died April 29. This marked the end of 40 years of intensive professional activity by one of the foremost contributors to the field of petroleum technology.

"Gus" had many honors bestowed on him during his lifetime. But it was neither his professional stature nor these honors that set him apart from so many others. It was rather an intangible—a feeling that even without them, he would have been remembered for his great love of his profession; a feeling of sincerity and genuiness that stimulated those with whom he came into contact.

Dr. Egloff's career paralled the period of greatest growth for the oil industry. He played a tremendous part in this growth as indicated by the 300 or so patents issued to him. He contributed greatly to the dissemination of technical knowledge with his more than 650 technical articles and 11 books.

Born in New York City of Swiss parents, Dr. Egloff received his B. A. from Cornell in 1912, his M. A. from Columbia in 1913 and his Ph.D from Columbia in 1915. He served as Director of Research for Universal Oil Products Company from 1917 until his death.

In the words of David D. Harris, President of Universal Oil Products Company "... the petroleum industry has lost a true and loyal friend who contributed immeasurably to its progress over the years. He was a man who was respected and admired by all who had the privilege of knowing him ... one who will be difficult, if not impossible, to replace."

Nicholls Joins Refiner Staff

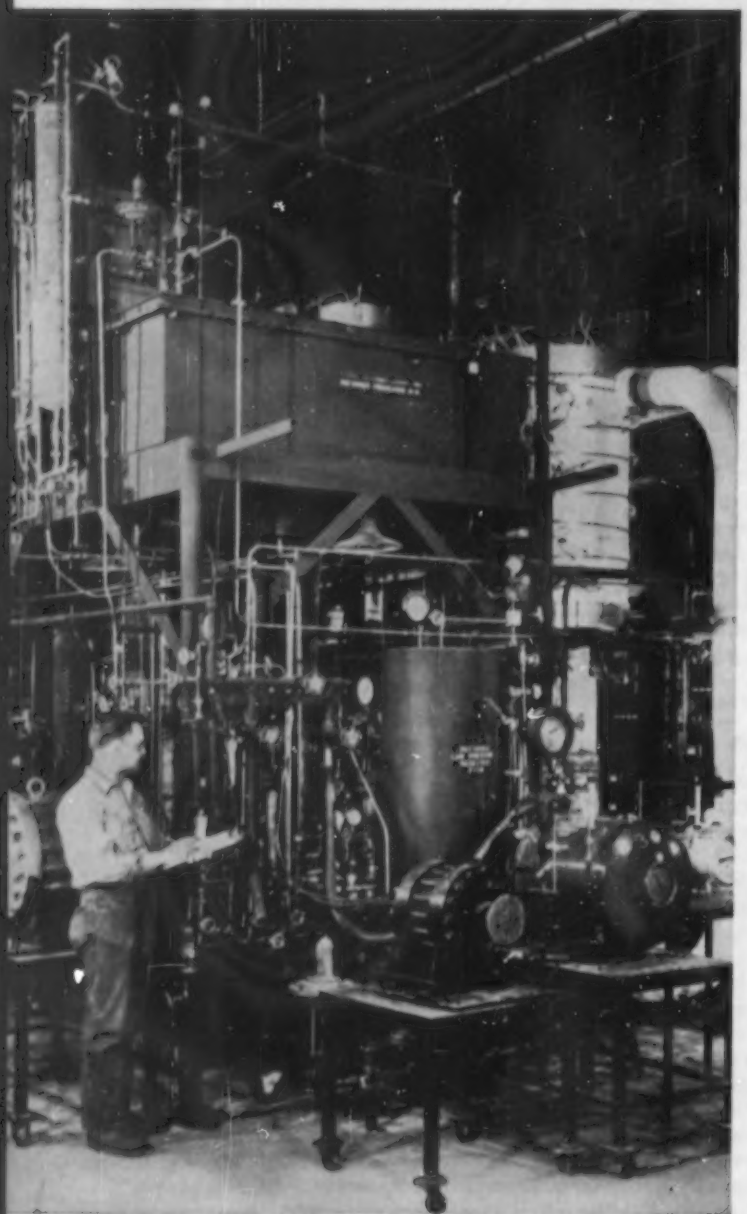
PETROLEUM REFINER has a new star in its firmament in the person of Paul E. Nicholls, Jr., who has been named Maintenance and Design Editor. His first day on the job was May 16; so by the time this appears in the reader's hands, he is well on the road to filling the editorial niche for which we think he is so well equipped.

Nicholls, a product of Texas A. & M. College, came to us from Port Arthur where he had been serving as engineer for The M. W. Kellogg Company which is building Gulf Oil Corporation's second 50,000-barrel cat cracker. For Kellogg, prior to the Port Arthur job, he was chief engineer during the construction of a 21,000-barrel catalytic reformer at Pan American's Texas City refinery, and chief instrumentation engineer for supervision of design, procurement and testing on AEC's gaseous diffusion plant at Paducah, Ky. Previously he had served as senior engineer in design and construction for General Electric, and field engineer-coordinator for C. F. Braun and Company as it built Shell Chemical's expanded facilities at Houston and The Pure Oil Company-Texas Gulf Sulphur Company's twin installation at Worland, Wyo. which among other things recovers sulfur from natural gas.

Our new maintenance-design editor also had his World War II days with Uncle Sam, having served with the U. S. Navy as maintenance officer on an operating dry dock at Midway and, a bit later, officer in charge of design and construction of a 6000-ton floating dry dock.

"We're very happy to add Paul Nicholls to our staff and we feel certain that his contributions to the editorial content of The Refiner will be noteworthy," Publisher Ray L. Dudley said. "He has a wide acquaintance in maintenance and design fields and our readers are sure to be hearing much from him in the future."

New catalytic reformates road-tested by Ethyl Research



Samples for analysis at Ethyl Research Laboratories are taken directly from the pilot plant of the reformate process developer.

In choosing one of the important new reforming processes, or in planning the over-all refinery operations once the plant is on stream, it is vital to know how the reformate will behave in the gasoline to be marketed.

That's where we can help you. Ethyl's Refinery Technology group in Detroit, working closely with the developers of these new processes, has prepared several reports on road antiknock behavior of reformates. And more reports are in process.

Each of these Ethyl reports is based on evaluation of reformate samples from commercial units or from the developer's pilot plant. We blend the new reformates with typical refinery base stocks—straight-run, catalytically cracked, and thermally cracked naphthas—to produce typical gasolines. "Ethyl" antiknock compound is then added, and the gasolines are road-tested on chassis dynamometers in our controlled-weather rooms.

Finally, all the information is collected, evaluated and submitted for approval to the developer of the process.

Reporting to the industry on the behavior of catalytic reformates is another example of how Ethyl is helping serve your needs.

If you have a problem in octane improvement, get in touch with your local Ethyl Refinery Technologist. He'll be glad to work with you.

ETHYL CORPORATION
Research Laboratories
1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

Final report on a new reformate process is presented to customer by Ethyl Fuel Technologist Alon Cole. This and other Ethyl Research reports are available to you through the Ethyl Refinery Technologist in your area.

Reformates are blended with various runs of gasoline and tested by Ethyl technicians.

Road testing is performed with various gasoline stocks in Ethyl's highly instrumented controlled-weather rooms.

FIGURE 1—Checking for a combustible gas with an explosimeter.

FIGURE 2—Hose-type masks used in toxic or combustible gases.

Control Work Hazards In Confined Areas

Safety of men and equipment depends on recognition of hazards and the prompt application of sound practices.

Kingsley Mull
The Pure Oil Company
Toledo, Ohio

THERE ARE FEW labor classifications that are exposed to the number or variety of hazards the maintenance man encounters as a routine part of his job. This is particularly true in the refining and petrochemical industries. His safety, that of the men working in the area, and the safety of the equipment all depend upon the prompt recognition of these hazards and the proper application of the best known safety practices. Momentary laxity can result in a catastrophe. Records show that failure to evaluate the hazards involved in doing a job or taking the necessary steps to control the hazards are the major contributing factors in most accidents. For men working in confined spaces, the problem becomes even more acute, for here the worker will find it difficult if not impossible to clear the area should the need arise.

Meet the Author

KINGSLEY MULL, who is technical maintenance foreman for The Pure Oil Company at its refinery in Toledo, Ohio, joined the company as a management trainee in 1949. Since then, he has served as a labor foreman and decoking foreman, and held a supervisory position in the company's Mechanical Engineering Department. Mull was graduated from Purdue University with a bachelor's in mechanical engineering.

Confined Areas—An area may be considered a confined area when ventilation must be supplied, entrance is through a restricted opening, or the work space is very limited. In this category fall storage tanks, accumulators, fractionating towers, furnaces, boilers, and pump rooms, these particularly on older units. In short, most process equipment and auxiliaries present some locations where maintenance work must be performed in a confined area.

Periodically, storage tanks and accumulators are opened for cleaning and inspection. Storage tanks are cleaned to permit repairs or before they are changed from one service to another. Accumulators often require installation of metal liners, particularly those in corrosive services. Fractionating tower internals must be inspected, and on occasion hand cleaning and tray replacements are necessary. The trend on newer towers has

FIGURE 3—Air eductor used for induced ventilation.

FIGURE 4—Safety sign to indicate men are in tower.

been to fewer manways. This means trays must be dismantled and removed when complete inspections are scheduled. Interior inspection is necessary in furnaces and boilers. There are tube replacements, tube support, breeching and fire box repairs. In pump rooms, piping changes and mechanical repairs are the rule, many times without the benefit of permanent handling equipment. Numerous crafts are engaged in the operation, and the work runs the scale from welding to scaffold erection.

Common Hazards—One of the most prevalent hazards to be found in the confined space is a contaminated atmosphere. The normal reaction is to accept an atmosphere mixture as being pure and clean for human breathing; if it is not too hot, the odor is not repulsive, or there are no visible signs of contamination: that is, no vapors, fumes or smoke are in evidence. Even these may be ignored if the first exposure does not produce a marked physical discomfort.

It is not uncommon to find hydrogen sulfide in units where sulfur-bearing petroleum or its derivatives are processed. This gas has a distinctively foul odor and is quite irritating to the eyes and throat. It is colorless and is heavier than air. The first contact with hydrogen sulfide will produce a marked physical discomfort, but the sense of smell will be deadened almost immediately if the concentration is high. Thus, the sense of smell cannot be depended upon for detecting the presence of an unsafe amount. Table 1 shows that it is very toxic and exposure to a high concentration for a short period can cause death.

The atmosphere in a vessel or area where hydrocarbons have been present may contain combustible vapors. The danger they present will depend upon the concentration.

A vessel or tank may contain

See WORK HAZARDS, page 227

TABLE 1. Toxicity of Hydrogen Sulfide to Men†

H_2S Percent	0-2 Minutes	2-15 Minutes	15-30 Minutes	30 Minutes—1 Hour	1-4 Hours	4-8 Hours	4-48 Hours
0.005 0.010				Mild conjunctivitis; respiratory tract irritation.			
0.010 .015		Coughing; irritation of eyes; loss of sense of smell.	Disturbed respiration; pain in eyes; sleepiness.	Throat irritation.	Salivation and mucous discharge; sharp pain in eyes; coughing.	Increased symptoms.*	Hemorrhage and death.*
0.015 .020		Loss of sense of smell.	Throat and eye irritation.	Throat and eye irritation.	Difficult breathing; blurred vision; light shy.	Serious irritating effects.	Hemorrhage and death.*
0.025 .035		Irritation of eyes; loss of sense of smell.	Irritation of eyes.	Painful secretion of tears; weariness.	Light shy; nasal catarrh; pain in eyes; difficult breathing; conjunctivitis.	Hemorrhage and death.*	
0.035 .045		Irritation of eyes; loss of sense of smell.	Difficult respiration; coughing; irritation of eyes.	Increased irritation of eyes and nasal tract; dull pain in head; weariness; light shy.	Dizziness; weakness; increased irritation; death.	Death.*	
0.050 .060	Coughing; collapse and unconsciousness.*	Respiratory disturbances; irritation of eyes; collapse.*	Serious eye irritation; light shy; palpitation of heart; a few cases of death.*	Severe pain in eyes and head dizziness; trembling of extremities; great weakness & death.*			
0.060 .070 .080 .10 .15	Collapse;* unconsciousness;* death.	Collapse;* inconsciousness;* death.*					

* Data obtained from experiments on dogs which have a susceptibility similar to men.
† From National Safety Council Publication Hydrogen Sulphide, Industrial Data Sheet D-Chemical 16.

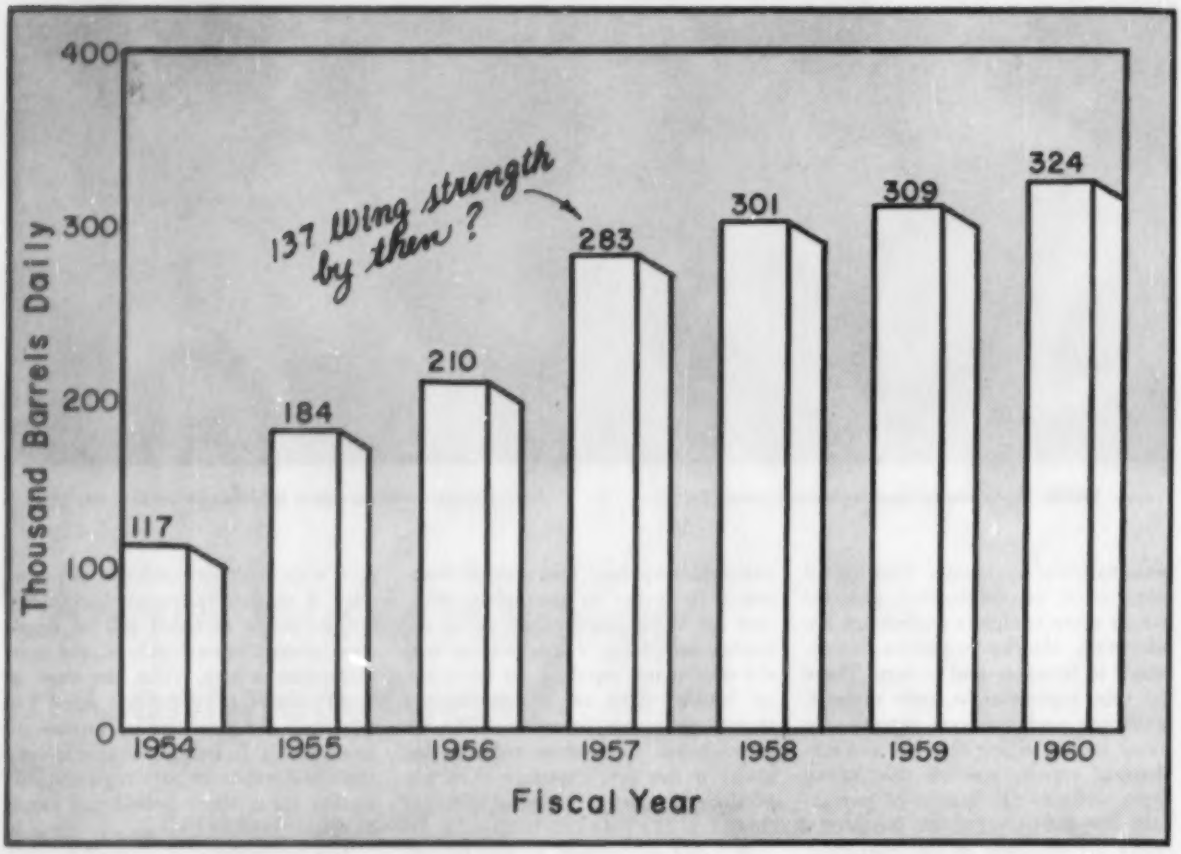


FIGURE 1—U. S. military jet fuel requirement (peacetime): A spectacular gain in the next few years.

Military Calls Jet Fuel Signals

Demand will make some spectacular gains in the next few years; JP-4 specification fuel overshadows other grades for the military.

George B. Gibbs
Refiner Staff

THE YEAR 1955 has already seen the beginning of turbo-prop service in one commercial airline in North America and another airline will take the plunge soon. (The first: Trans-Canada Air Lines; the next: Capital).

But don't expect overnight changes in the civilian picture. Even by 1960, the military will still be the most dominant figure in tl.e jet fuels picture.

There are of course the two big *if's* in any military analysis: *if* there is no total war emergency and *if* there is no disarmament program. The assumption is that there will be a continuation of world tension and a constant state of preparedness in the United States.

At the present time, JP-4 specification fuel overshadows other jet fuel blends. A recent survey[1] (Table 1) shows the jet fuel analysis of various grades now supplied by 15 refiners. Not much change has occurred in blends as can be seen by comparison of the year 1954 with 1951, 1952, and 1953.

Figure 1 shows present and probable purchase of JP-4 by the Defense Department. From the present rate of 184,000 barrels per day, the increase is rather marked through 1957. From then on, the increase is not quite so spectacular—the reason being that 1957 is the target date by which the Air Force will have reached its 137 wing strength now authorized by Congress.

These figures represent only JP-4 fuel. The utilization

TABLE 1—Inspection Tests on Jet Fuels[1]

INSPECTION TEST	GRADE JP-1		GRADE JP-3					Referee JP-3 '51	GRADE JP-4					REFEREE JP-4			GRADE JP-5		
	1951	1952	1951	1952	1953		1954		1951		1952	1953	1954	1952	1953	1954	1953	1954	
Number of fuels	9	3	23	6		2*	4	1		2*	24	28	23	1	1	1	1		2*
Gravity, °API	42.2	42.3	53.7	52.5	55.6,	50.7	56.5	47.1	53.6,	55.1	50.5	51.8	51.5	45.6	45.4	48.1	37.3	37.8,	41.0
Distillation Temp.:																			
10 percent evap., °F	345	338	163	166	165,	194	160	151	216,	193	222	220	216	238	240	244	397	384,	395
50 percent evap., °F	378	368	313	316	301,	340	265	344	289,	297	332	324	319	348	349	361	432	418,	424
90 percent evap., °F	437	421	435	433	446,	426	421	480	407,	440	430	421	425	455	461	457	491	470,	480
400 F. points, percent evap.							84						82.5			72.0		27.5,	16
Reid vapor pressures, lbs.			5.9	6.0	5.7,	5.5	5.7	6.9	2.5,	3.0	2.6	2.5	2.6	2.3	2.2	2.5	0.5		
Freezing point, °F	<−76	<−76	<−76	<−76	<−76,	<−76	<−76	<−76	<−82,	−78	<−76	<−76	<−76	<−76	<−76	<−76	−54	<−40,	−59
Viscosity, kinematic, −40 F, cs	8.29	8.59	2.91			3.26	2.15	3.36	2.51,		4.18	3.68	3.28	3.73	3.80	3.41	19.4	12.1,	13.36
Water tolerance, ml.	0.0	0.0	0.0	0.0	0.0,	0.0	0.0	0.0	0.0,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0,	0.0
Aniline point, °F	132.8		134.5	133.9	132.9,	124	130.5	107	140,	137.9	133.9	134.8	133.8	110.8	106.5	131.4	136	129,	146
Aniline-gravity constant	5,604		7,223	6,505	7,380,	6,287	7,373	5,040	7,504,	7,598	6,762	6,983	6,891	5,052	4,835	6,330	5,073	4,876,	5,986
Bromine No., gm. Br/100 gm.	0.95	1.57	2.59	2.30	1.52,	1.54	1.06	7.3	0.96,	1.4	1.91	1.63	1.59	13.0	19.6	5.60	4.3	3.7,	0.80
Sulfur:																			
Total Wt. Percent	0.079	0.057	0.085	0.081	0.077,	0.048	0.089	0.35	0.074,	0.119	0.075	0.074	0.080	0.301	0.265	0.177	0.46	0.33,	0.075
Mercaptan	0.0009	0.0017	0.0008	0.0010	0.003,	0.001	0.001	0.0005	0.003,	0.0017	0.0010	0.0014	0.0016	0.003	0.002	0.001	0.003	0.001,	0.001
Aromatic content, vol. percent	14.3	14.3	11.3	14.7	12.3,	16.0	10.3	25	12.2,	10.0	11.9	11.9	11.3	20.4	20.3	16.4	8.3	20.3,	15.13
Olefin ocntent							0.6						1.3			2.3		0.9,	0.87
Smoke point							29.4						28.7			23		21,	21
Smoke volatility index							64.7						63.4			53.2		33,	27.7
Gum:																			
Existent:																			
Air-jet, 400 F, mg./100 ml.	1.4	1.7	1.7	0.9	0.7,	0.4	1.6	1.2	1.4,	0.0	1.2	1.3	1.3	3.8	2.8	1.4	3	2,	
Steam-jet, 450 F			2.2			0.4	1.5	1.8	3.2,	0.4		0.7	0.6			1.0	2	1,	1.0
Accelerated:																			
Air-jet, 400 F	1.5	1.5	4.1	5.9	1.5,	2.9	1.8	8.4	6.2,	1.0	3.3	2.9		* 19.0	13.4	14.5	5	2,	
Steam-jet, 450 F			3.7			2.4	1.9	11.4	3.2,	0.3		1.7	2.5			9.3	4	1,	1.0
Heat of combustion, net, Btu/lb.	18,556	18,551	18,717	18,642	18,716,	18,555	18,715	18,484	18,756	18,735	18,671	18,714	18,678	18,452	18,467	18,582	18,474	18,391,	18,569
Hydrogen-carbon ratio	0.1610		0.1649			0.1575	0.1680	0.1570	0.1605,	0.1709		0.1649	0.1635			0.162	0.159	0.157,	0.151

* As only two samples are represented, average values were not computed.

THE JET FAMILY

There are three basic types of jet propulsion units as follows:

Turbo-jet: Its principle parts are the compressor, burner, turbine, and jet nozzle. The jet stream is used to propel the plane, the turbine's function being to drive the compressor. Most U. S. military planes are this type.

Ram-jet: This unit is the simplest one (no turbine or compressor), consisting of a long tube with slightly restricted open ends. Air enters through a diffuser.

Turbo-prop: This unit is similar to the turbo-jet except that the turbine has the added function of driving propellers. About 20 percent of the engine's thrust comes from jet and 80 percent from propellers. It's the unit finding immediate application in the commercial transport field.

by the military of a heavier fuel (JP-5 type) will increase over the period 1955 to 1960 but it is primarily designed for supersonic aircraft and in supersonic missiles, representing a small barrel per day consumption.

Though the military is making rapid changes to jet-powered aircraft there will still be a heavy demand for aviation gasoline for combat reciprocating aircraft (100,000 barrels daily vs. 324,000 barrels jet fuel in 1960). General White[2] of the U. S. Air Force has put a strong case for such a demand as follows: "It is true every fighter aircraft in the Air Force is now jet propelled, and many of our medium bomb wings are rapidly being converted to B-47 jet bombers. However, on the other side of the ledger—our transports and support-type aircraft are being replaced with larger type aircraft which not only consume more fuel but require grade 115/145 instead of grade 100/130. For example, the B-29 wings, which are being replaced by B-47's, normally consume about 500 barrels per day, while a wing of the giant transport, such as the C-97, consumes about 1500 barrels per day or about three times the quantity of a wing of the B-29. Another factor which will have a bearing on our future aviation gasoline requirement is the converting of SAC's aerial tankers from KB-29's to the more powerful KC-97's, which are larger consumers of high octane gasolines. Although the B-47 rapidly is taking over as the standard SAC medium bomber, the B-36 today is the heavy bomber and will be until the B-52 is placed in tactical units. The B-36 fleet is likely to remain active service for a good many years with duty as a radar picket plane, and possibly as an aerial tanker for jet bombers."

The impact of jets on the civilian picture will be gradual. It has been said that aircraft do not wear out any more for two reasons (the first DC-2 ever built is still on a regularly scheduled operation): First, they represent a very large investment in durability. Second, under the regulations of the Civil Aeronautics Administration, civilian aircraft must go through an overhaul periodically. When they do, they are brought more or less up-to-date.

Cost and safety-conscious domestic airlines have postponed starting jet operations as long as possible. Though the cost of the newest piston-engine planes, such as the DC-7 and the Super-Constellation, is as high as a million and a half dollars per plane, the cost of a turbo-jet plane is about three to four times this amount—more than $5 million. U. S. airplane manufacturers have handled orders for more than 300 piston-engine aircraft scheduled for delivery to airlines through the year 1955. This picture indicates that jet planes will supplement—not supplant—piston engine transport in the foreseeable future.

What type of fuel will be selected for jet planes of the future will depend on the cooperative views of the four parties involved in the aviation world—the engine manufacturer, the airframe manufacturer, the airline operator and the petroleum refiner. For a look at the refiner's viewpoint, see the next article, "Kerosine or JP-4 for Commercial Transports."

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What's Ahead for Jet Fuels

Kerosine or JP-4 for Commercial Jets?

Both are available and about equal in cost in a given area; West Coast prices will be somewhat higher than Gulf Coast prices.

E. J. McLaughlin and J. A. Bert
California Research Corporation
Richmond, Calif.

PROSPECTIVE COMMERCIAL jet fuels ranging from gasoline to heavy fuel oils have been proposed over the years. Within the last year, however, the selection has been narrowed to three types for domestic use. These three are: JP-4, commercial kerosine, and a low freezing point kerosine (JP-1).

Fuel cost and availability are important factors in the final selection of fuel type. A detailed consideration of the factors involved in the availability, distribution, and costs of the three fuels shows that the petroleum industry could supply any of the three fuels in quantities adequate to satisfy commercial airline fuel demands and that kerosine and JP-4 would be about comparable in cost. JP-1 would be the most costly fuel.

Fuel Specifications—Typical physical properties of JP-4, kerosine, and a low freezing point kerosine are given in Table 1. JP-4 is a wide boiling range fuel that includes some of the gasoline, kerosine, diesel, and furnace oil components. It boils between about 135 and 485 F. Very large amounts of JP-4 can be produced readily for possible military demands as theoretically about 40 to 50 percent of the crude oil production could be converted to this fuel. Actually, the conversion would be less because kerosine, gasoline, and diesel fuels would also be required in time of war.

Kerosine is a narrow boiling range fuel compared with JP-4 and boils between about 325 and 525 F. The freezing point is about —40 F., and it is used in lamps, stoves, and other devices which have critical burning requirements. About 10 to 15 percent of crude oil production could be converted to kerosine.

JP-1 fuel is a kerosine with a low freezing point, below —76 F., and a narrower boiling range, approximately 325 to 450 F., than most commercial kerosines. About 6 to 8 percent of crude oil production could be converted to this type of kerosine.

The significance and importance of certain fuel properties on safety, engine, and airframe requirements are subject to considerable interpretation of available technical information. As an example, whether the ideal jet fuel should have high heat value on a weight (Btu/lb.) or on a volume (Btu/gal.) basis depends on whether the airplane is weight or volume limited. Although the fuel supplier is vitally interested in the factors affecting over-all aircraft performance, the fuel properties required to satisfy the various, often conflicting, requirements will have to be resolved jointly by the airline operator, the engine manufacturer, and the airframe manufacturer.

Jet Fuel Demand—The civilian jet fuel demand should not significantly affect the supply of other liquid petroleum fuels through 1965. Figure 1 shows that present civilian aviation gasoline is less than 1 percent of the total U. S. petroleum product demand. The need for airline jet fuel will probably be even less; 0.2 percent in 1960 and 0.3 percent in 1965.

The peacetime military demand for jet fuel is about 2 percent of the total

Meet the Authors

E. J. McLAUGHLIN, who is supervisor of California Research Corporation's Engine Fuel division at Richmond, Calif., has been associated with the company since 1935. Joining the company shortly after his graduation from Oregon State College, where he received a degree in mechanical engineering, McLaughlin first was assigned to gasoline studies and later took up assignments in diesel and aviation fuels. He was appointed to his present position with the company in 1946.

J. A. BERT also has been connected with California Research Corporation since his graduation from Oregon State. He received his mechanical engineering degree there in 1944 and immediately joined the company at its Richmond laboratories. He has been concerned primarily with the performance characteristics of aviation fuels and lubricants for reciprocating-piston engines and gas turbines. In 1950 he received an appointment as senior research engineer for aviation products.

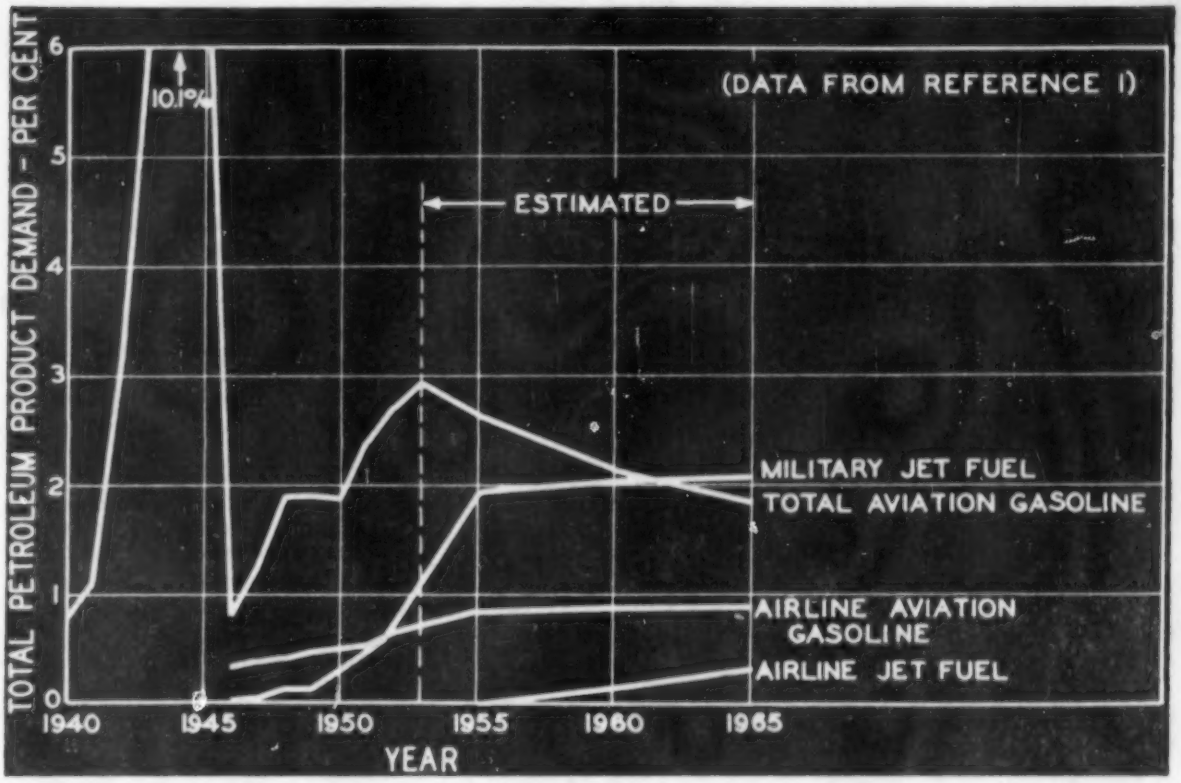

FIGURE 1—Demand for aviation gasoline and jet fuel, 1940-1965.

product demand, and this will probably not change materially in the next ten years. In 1965, therefore, the military jet fuel demand would be about seven times that of the civilian demand. In time of war, the military demand would be high, probably greater than the 10.1 percent for aviation gasoline attained during the last war.

Availability of Jet Fuels—Adequate quantities of any of the three fuels could be supplied for commercial airline use because of the small demand. But neither of the kerosines could be supplied in time of war in sufficient amounts to meet all of the military requirements for jet fuel. Military wartime petroleum requirements would demand a large quantity of the kerosine distillates, and under such circumstances it is possible that a special kerosine jet fuel could not be supplied for commercial airline use.

From a cost standpoint, it would be advantageous to adapt the commercial aviation gas turbine engine to fuels already available throughout the petroleum fuel distribution system. The cost of supplying an already available fuel would be much less than the cost of supplying and distributing a new fuel for use in commercial aircraft gas turbine engines only.

Price Structure of Jet Fuels—The price of kerosine was studied by obtaining prices quoted for a number of years at different locations throughout the country. Absolute prices varied with time (Figure 2);[3] but if the ratio of kerosine price to average crude oil price is used, an approximate index can be obtained as shown in Figure 3.[3] The Gulf and West Coast prices were chosen for these comparisons because they represent areas of major differences in product demand and price, and the differences between the posted kerosine prices have been frequently questioned. The Gulf, Midcontinent, and New York prices of kerosine, JP-1, and JP-4 fuels are in the same relative order as Gulf prices on these fuels.

Figure 2 shows that the postwar average wholesale price of kerosine at the Gulf Coast is about three cents a gallon lower than in California. Figure 3 shows that, for the past 20 years, kerosene price was about 1.4 times the crude oil price at the Gulf Coast and about 2.1 times the crude oil price in California.

The price differential between California and Gulf Coast kerosines is caused by three factors. First, California crude oils, in general, require more refining to obtain a suitable kerosine. Second, production, as well as demand, for kerosine on the West Coast is far below the national average of about 6 percent of crude production, as shown in Figure 4.[4,5] The kerosine production of the five Western states represents only 1 percent of the processed crude in the same area, while in the Gulf Coast Area it represents 9 percent. Third, the California tank car prices and Gulf Coast cargo prices are not exactly comparable, but are posted prices available in each area. Tank car prices are more commonly used for small volume deliveries and are, in general, somewhat higher than cargo prices. Therefore, the higher West Coast price is caused primarily by handling and distributing costs of a

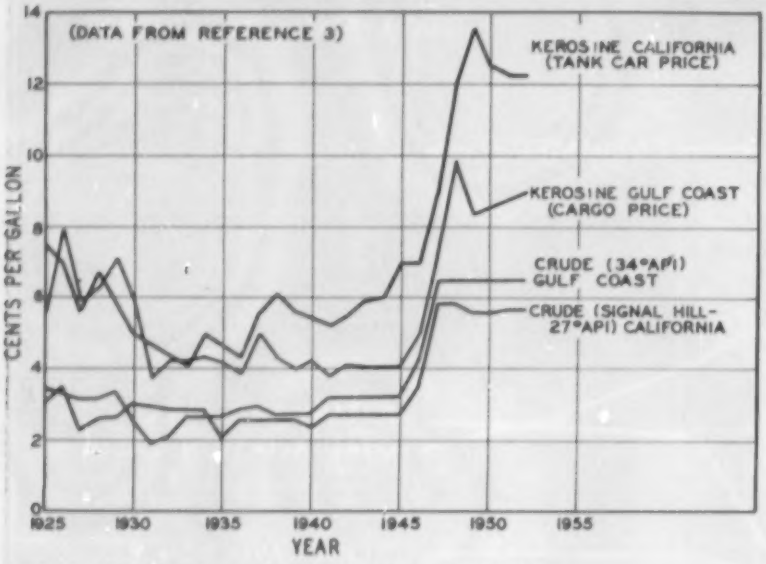

FIGURE 2—Price of crude petroleum and kerosine in U. S. A. from 1925.

low volume product and to a lesser extent by higher manufacturing costs.

If kerosine were adopted as the principal commercial jet fuel, the differential between Gulf and West Coast kerosine prices to the airlines would be less because of the lower unit cost for handling and distributing large volume deliveries. It is assumed that the higher refining costs will cause California kerosine price to be 1.5 to 2.0 cents a gallon higher than Gulf Coast kerosine price. In subsequent comparisons, therefore, an average of 1.8 cents a gallon differential is used between California and Gulf Coast kerosine prices.

Unfortunately, competitive prices for JP-1 and JP-4 fuels are not available before 1954 because, prior to that date, prices on jet fuel were established by negotiation between the government and the petroleum manufacturers. Furthermore, during the years when JP-1 and JP-4 were being manufactured simultaneously, there was a nationwide petroleum shortage and a war in Korea, both of which upset the balance between supply and demand. In view of these factors, JP-4 and kerosine price comparisons are based on relatively meager JP-4 price data.

Table 2 shows average bid prices for military JP-4 grade jet fuel in October, 1954[2] and the low quoted wholesale price of kerosine.

Cargo prices in the Caribbean Area can also be used for comparison of JP-4 fuel and kerosine.[7] In 1953, kerosine was about 0.5 cents a gallon cheaper than JP-4, while prices were the same during 1954.

There are no commercial prices available on JP-1 fuel, but it is more costly than kerosine. An important factor in the increased price of JP-1 over kerosine is the relatively low production volume and additional handling facilities required at the refinery for a special fuel. JP-1 fuels also require selection of stock or additional refining, as compared with commercial kerosine. The probable cost for the additional refining and handling of JP-1 as compared with kerosine will be between about one and two cents a gallon.

In view of the foregoing discussion and assumptions, the relative wholesale cargo prices per gallon of the petroleum products may be summarized as shown in Table 3.

Because fuel is purchased by the gallon, the heating value of the fuel per gallon must be considered in estimating the true value of the fuel.

TABLE 1
Typical Properties of Kerosine JP-1 and JP-4 Fuels

INSPECTION	JP-1*	JP-4*	Kerosine
Gravity, °API	42.2	52.1	43.0
Distillation Temp., F.			
10 Percent Evap.	345	220	380
50 Percent Evap.	378	324	435
90 Percent Evap.	437	421	480
Reid Vapor Pressure, lb.	.....	2.5	.....
Freezing Point, F.	<—76	<—76	—20 to —40
Viscosity, Kinematic, —40 F., cs	8.29	3.68	.....
Analine Point, F.	132.8	134.8	.....
Bromine No., gm Br/100 gm	0.95	1.63	.....
Sulfur			
Total, Weight Percent	0.079	0.074	0.040
Mercaptan, Weight Percent	0.0009	0.0014	.....
Aromatic Content, Vol Percent	14.3	11.9	10
Gum			
Existent	.....	.....	.....
Airjet, 400 F., mg/100 ml	1.4	1.3	.....
Steamjet, 450 F. mg/100 ml	.....	0.7	.....
Accelerated			
Airjet, 400 F.	1.5	2.9	>4
Steamjet, 450 F.	.....	1.7	.....
Heat of Combustion, net.			
Btu/lb.	18,556	18,714	18,600
Btu/gal.	125,800	119,900	126,000
Hydrogen-Carbon Ratio	0.1610	0.1649	.....
Flash, Tag Closed Cup, F.	110**	—54**	135

* Average data from Reference 6.
** Calculated.

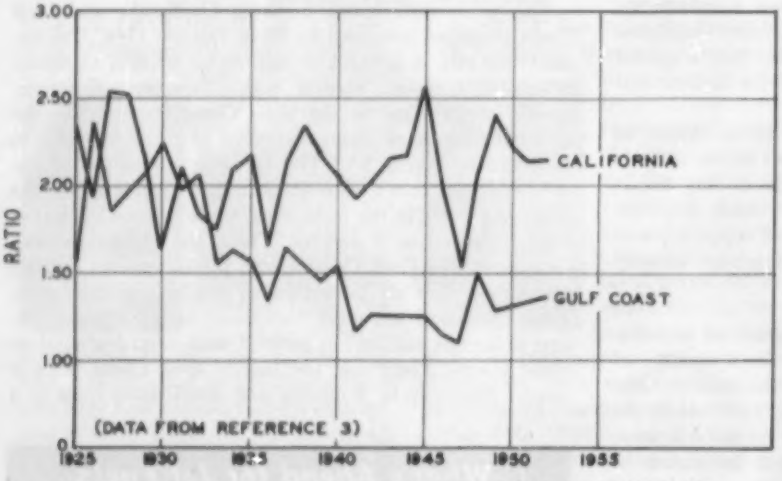

FIGURE 3—Ratio of wholesale kerosine price to crude petroleum price, 1925-1952.

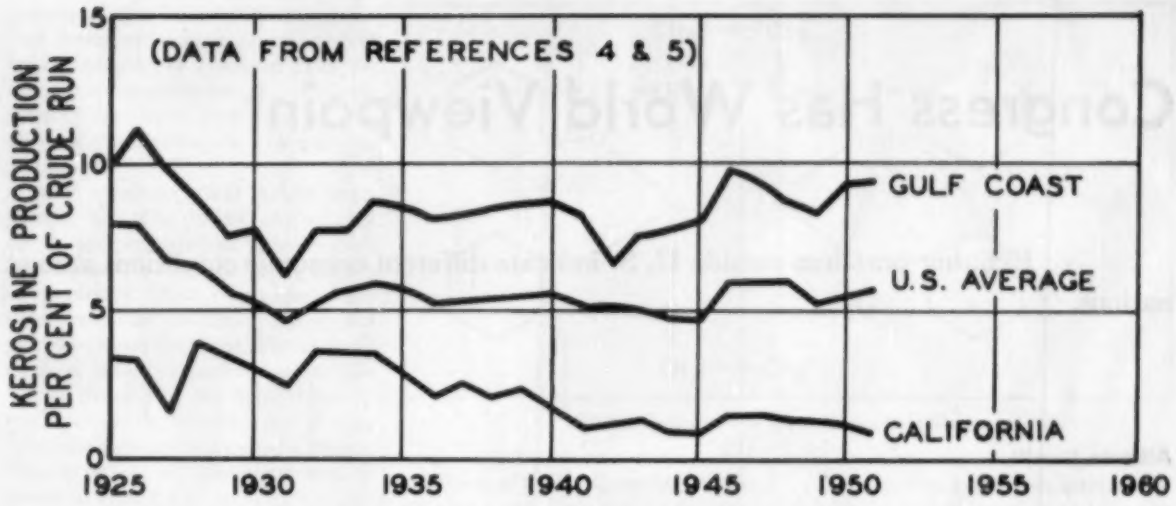

FIGURE 4—Kerosine production in California, Gulf Coast and United States.

Heating value is important because of the relatively higher values of kerosine and JP-1 fuel. Combining the price per gallon and the heating value per gallon into a common factor would simplify fuel cost comparison. A convenient term is cents per therm (100,000 Btu) which is commonly used in the gas industry. Using the heating values shown in Table 1 and the price figures from the above table, the comparison of price in terms of cents per therm is shown in Table 4.

The value of this concept of expressing prices may be illustrated by comparing kerosine and JP-4 West Coast prices. JP-4 is 2.8 percent cheaper than kerosine on a cents-per-gallon basis, while on a cents per-therm basis kerosine is 2.3 percent cheaper than JP-4. The fuel price per therm must be used in conjunction with the payload for each airline operation to decide on the most economical fuel because the heating value per pound is lower for the kerosine than for JP-4 fuel. Therefore, the fuel load for a given number of Btu's (equivalent range) would be greater for kerosine, and the price differential must be weighed with the greater payload that could be carried with the lighter JP-4.

TABLE 2
JP-4 and Kerosine Prices, October, 1954

	JP-4, Cents/Gallon	Kerosine, Cents/Gallon
	Cargo	Cargo
Gulf Coast	9.3	9.0
West Coast	10.5	10.8*

* Estimated.

TABLE 3
Relative Cargo Prices of Jet Fuels

	WHOLESALE CARGO PRICES, CENTS/GALLON	
	Gulf Coast	West Coast
Kerosine	9.0	10.8
JP-1	10.5	12.3
JP-4	9.3	10.5

TABLE 4
Jet Fuel Price Comparison on a Therm Basis

	GULF COAST	WEST COAST
	Cents/Therm	Cents/Therm
Kerosine	7.1	8.6
JP-1	8.3	9.7
JP-4	7.8	8.8

Transportation Costs—It should be emphasized that the fuel prices discussed above are all wholesale cargo prices and are not the prices of the fuels delivered to the airplane fuel tank. To obtain the price of a fuel in the airplane fuel tank, it is necessary to add transportation, distribution, handling, and airport costs. Although the handling and airport costs vary from one airport to another, relative prices would be the same at any one location regardless of fuel type selected for commercial jet fuel use.

Each airline should discuss with its respective fuel suppliers the differences in "at the airport" fuel prices so that differences in distribution and transportation are included in economic evaluations.

Summary

Availability—Based on the estimated demand for domestic airline jet fuel, the petroleum industry could supply any of the three fuels discussed above; namely, kerosine, JP-1, or JP-4. The relatively small demand for airline jet fuels would not have a major effect on fuel availability.

Fuel Price—In general, kerosine and JP-4 will be about equal in cost in a given area. West Coast prices will be somewhat higher than Gulf Coast prices. JP-1 will be the highest priced of three jet fuels.

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What's Ahead for Jet Fuels

Congress Has World Viewpoint

Refining practices outside U. S. indicate different economic conditions among nations.

Alberto Girelli
Milan, Italy

U. S. OIL MEN contributed 58 of the 233 discussions presented at the Fourth World Petroleum Congress at Rome, Italy, June 6-15. Many of the refining problems faced by countries outside of the U. S. have been overcome by technical advances in the United States; but then the economic conditions of these countries are quite different (less severe octane requirements, different demand distribution of finished products, etc.). Refiners took note of the following developments which were presented by authors from these countries.

Urea Adducts—The attention of several authors has been directed at the development into commercial scale of the urea adducting reaction with normal aliphatic hydrocarbons. This process, through which a selective separation of normal alkanes from petroleum fractions can be achieved, is particularly attractive for the refining industry. Research has been carried on at the Société Francaise des Pétroles BP,[1] where a semi-commercial unit has been operated for more than one year. The process as developed by the French authors, called the Cristex process, is based on the use of urea dissolved in a ternary solvent (CH_3OH 56 percent—monoethylene glycol 25 percent—water 19 percent), non-miscible with hydrocarbons, and includes the following steps:

1—Reaction between the non-miscible phases (urea solution and hydrocarbons) by intimate mixing and chilling. 2—Separation by "turbulent settling" of the crystalline adduct from the raffinate. 3—Washing of the crystalline adduct with a light petroleum solvent, and separation of the solvent used. This step is necessary only when a highly purified extract is wanted. 4—Heat decomposition of the adduct, followed by separation of the extract from the urea regenerated solution. 5—Distillation of the wash solvent.

To avoid obstruction of pipes, the authors have studied different schemes, such as the use of technical grade urea (1 percent biuret content) which forms smaller crystals, a high speed of circulation of the adduct slurry, and the settling of the latter under vibrations, which avoids the purification of the complex to be carried out as a separate step.

The technique described has been applied to upgrading octane of gasoline, to improve jet- and Diesel-fuels, and to the production of normal paraffin cuts (for chemical syntheses or for special applications).

A different approach to the industrial development of the urea adduct reaction has been tried at the Shell Research Center at Chester, England.[2] The problems involved in the filtration step of the conventional procedure have been overcome by addition of surface active agents. The tendency of these agents to render somewhat difficult the final separation of the extracted oil from the regenerated urea solution has been eliminated by addition of inorganic salts (in particular, ammonium carbonate). The addition of surfactants and of inorganic salts to the aqueous urea solution has the disadvantage of slowing down the reaction rate of urea with normal alkanes; this shortcoming, however, is counterbalanced by the simpler design and by the easier operation of the plant. The "non-filtration" process, as the author has named his method, proved particularly suitable when extracting liquid feedstocks with a content of extractable hydrocarbon above 30 percent. The conventional (filtration) method and the improved method proposed should be considered as complementary rather than as competitive.

The application of urea adduct formation to the dewaxing of lubricating oil fractions has been investigated at the Assam Oil Company of Digboi, India.[3] From comparative tests carried out, dewaxing by the conventional methyl-ethyl-ketone (MEK) solvent process and by the urea adduction reaction a distillate lubricating fraction from India crude, the following conclusions have been reached by the author. Urea adduct formation is unlikely to develop into a serious rival to the conventional dewaxing processes. Though the use of the urea process does not involve severe refrigeration (as MEK process does), it lacks the flexibility of the latter, and would imply the use of larger equipment for the same operating capacity.

The three discussions of the urea adduction process presented before the Congress clearly demonstrate the interest of the oil industry in a thorough investigation of the commercial applicability of the process itself. The same is probably not economically applicable at the present stage of development of the technique, but may possibly develop in the near future into an interesting auxiliary

process of petroleum refining.

A novel sweetening process, based on the employ of chemical reagents never introduced before in petroleum refining has been presented by authors of the Compagnie Francaise de Raffinage.[4]

Some organo-metallic kelate compounds are able to fix oxygen (in proper temperature and pressure conditions) and to release it at higher temperatures. These compounds have been tested as sweetening agents for petroleum sour fractions. The organometallic reagents studied are cobalt kelates, formed by the Schiff base resulting from the combination of salicylic aldehyde and ethylenediammine. The structure of the compound is shown in Figure 1.

It is a dark brown, solid powder. It can be easily prepared by contacting an aqueous solution of the sodium salt of the Schiff base (disalicylal-ethylenediammine) with a cobalt salt solution (chloride, nitrate, or acetate). An alternate preparation method consists in treating simultaneously (in hydroalcoholic solution) stoichiometric quantities of the following reagents: salicylic aldehyde, ethylenediammine, cobalt salt, and sodium hydroxide.

The kelate compound adds oxygen at room temperature and pressure, and releases it at about 110 C. The reaction is reversible, in the sense that, after cooling, the deoxygenated complex can add oxygen, at a reaction rate as high as the oxygen partial pressure. When the complex, in its oxygenated form, is contacted with mercaptans, the latter are oxidized to disulfides, at room temperature. The reaction has been experimented on several petroleum fractions, and two different procedures have been studied. The first, which proved particularly suitable for sweetening fractions of high R-SH content, consists in contacting the product to be sweetened with an equal volume of an hydroalcoholic dispersion of the kelate. The second involves the addition of the kelate (in cresolic solution) to the product to be sweetened. Quantity of kelate to be used is in the order of 1 g for 8 - 12 g R-SH sulfur to be oxidised.

Kelate sweetened products, on storage, can undergo a certain discoloration, which can be eliminated either by a proper wash, or by filtration on a crystalline bed of alkaline bisulfate.

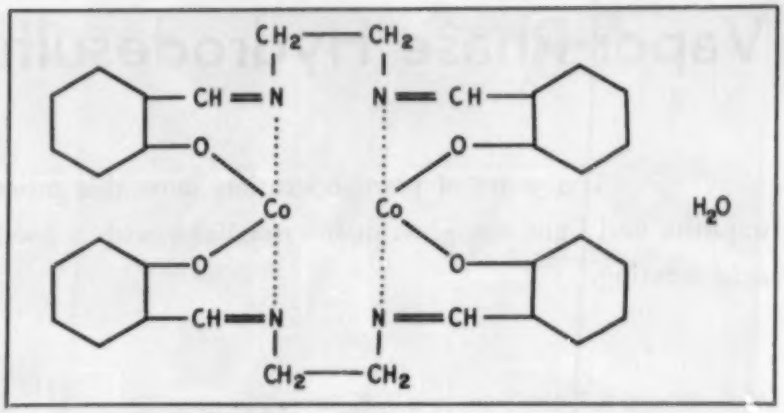

FIGURE 1—Structure of cobalt kelates looks like this.

Effects of Sulfur Content—Authors of the Fuel Experiment Station, Milan, Italy, presented an extensive investigation on the fundamentals of petroleum sulfur compounds decomposition, and the results of laboratory and commercial runs of low-pressure vapor-phase desulfurization of light distillates from Middle East crudes.[5]

While ample data are available on the relation between sulfur compounds and TEL efficiency, those referring to the effect of sulfur on the clear octane number are scarce and partly discordant. Several workers, however, have agreed on the point that mercaptan, sulfide, and disulfide sulfur definitely lowers the clear octane number, even in low concentration. A comparison of data from experiments carried out by the authors, on 60 O.N. primary reference fuel, with those reported in the literature (related to pure hydrocarbons, primary reference fuels, and commercial gasolines) showed that the influence of sulfur compounds on clear octane is stronger on pure hydrocarbons and primary reference fuels than on gasolines. At equal sulfur level, the greatest depressing influence is exerted by mercaptans, followed by sulfides and disulfides, whose influence is almost equal.

Desulfurization of gasolines and synthetic blends of hydrocarbons and sulfur compounds has been investigated over different catalysts (bauxites of different origin, synthetic aluminas). Bauxites have shown wide discrepancies in catalytic behavior. Surface area of the catalysts determines their carbon-bearing capacity. High surface area catalysts can withstand higher percentages of carbon deposits without losing activity.

Bauxite desulfurization is a process which is still being adopted by the Italian refining industry. The process is applied to refining straight run, low-e.b.p. gasolines, and sometimes combined with thermal reforming or with "Perco" type reforming operations.

British Petroleum Company (formerly Anglo Iranian Oil Company) has developed, through studies at the Sunbury (England) Research Station, wider applications for its Autofining process.[6] The process, adopted in industrial operations for desulfurizing lower boiling distillates (naphthas and kerosine), has been successfully extended to the production of low-sulfur diesel fuels. Diesel oils from Middle East crudes having sulfur contents from 1.0 to 1.3 wt. percent, can be refined to about 0.1 wt. percent sulfur. The improved catalyst is of the cobalt and molybdenum oxides on alumina type, activated with fluorine. The catalyst can be regenerated by conventional techniques. Minor loss of fluorine by partial hydrolisis of the metal fluorides are restored by addition of organic fluorides either to the feedstock or to the recycle gases.

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Vapor-Phase Hydrodesulfurization

Ten years of plant operation show this process can be applied to cracked naphtha and light straight-run intermediates with a good payout when compared with acid treating.

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DURING THE WAR refiners were required to supply larger quantities of grade 100-130 aviation gasoline. Catalytically cracked naphthas were available for this use. They contained large quantities of aromatics and had good rich-mixture octane rating. Because of the high unsaturate content and, in most cases, the high sulfur content, the gum was high and the leaded lean-mixture rating was low. Conventional refining with sulfuric acid gave very high treating losses and, therefore, hydrodesulfurization was investigated as an alternative. A process was developed for controlled hydrogenation of these stocks to give quantitative yields of products meeting aviation-gasoline specifications.[1a]

During the war Shell Oil Company built two plants for vapor-phase hydrodesulfurization of cracked naphthas. One was built at Dominguez, Calif., and one was built at Wood River, Ill. Both were designed to treat catalytically cracked naphthas with a 300-F, end point for aviation base stock.

At the completion of the war, when the demand for aviation gasoline decreased, these units were available for other service. The Wood River unit has been used to make light distillate fuel oil and mineral spirits from high-sulfur straight-run West Texas distillates. The Dominguez unit has been used to treat 250 to 430-F, catalytically cracked naphthas and 200 to 420-F, thermally cracked naphthas for motor gasoline.

Process Flow — Flow through the unit is shown in Figure 1. The unit consists basically of an adiabatic reactor, a preheater, heat-exchange equipment, flash tanks for separating gas and products, compressors for recycling hydrogen, and treaters for removing hydrogen sulfide from both the recycle gas and the liquid product.

Raw feed is first mixed with hydrogen, and the combined stream is preheated by heat exchange with reactor products and then in a furnace. From the furnace the feed passes in vapor phase to the adiabatic reactor. Reactor product is heat exchanged with cold feed and then cooled by heat exchange with water. Gas remaining after the cooling step is treated so as to remove hydrogen sulfide and is then recirculated. Makeup hydrogen is added to the recycle hydrogen. Liquid product from the high-pres-

Meet the Authors

MORTIMER D. ABBOTT, who is assigned to Shell Development Company's Process Engineering department at Emeryville, Calif., attended Massachusetts Institute of Technology for undergraduate and graduate studies in chemical engineering from 1933 to 1938. Now assigned to Shell Development Company's Process Engineering department at Emeryville, Calif., he formerly was connected with Humble Oil & Refining Company, C. F. Braun & Company and Pabco Products, Inc. During World War II he worked on the Manhattan Project.

GEORGE E. LIEDHOLM has been with Shell Development Company more than 20 years. A California Institute of Technology graduate in applied chemistry, he joined the Shell organization after two years with Procter & Gamble Company, and since has been active in process design of catalytic-cracking and catalytic-reforming plants and in synthetic liquid-fuels projects. During World War II, he served as a member of the committee which gave technical guidance to all toluene-producing facilities.

DANTE H. SARNO, with Shell Development Company since 1937 and now assigned to the company's Process Engineering department, is a group leader in fractionation research. Previously associated with The Texas Company, his primary field of interest is in applied research and design of distillation processes. Sarno has a background of many years experience in the design and operation of processes for the recovery and purification of petrochemicals, aromatics and light hydrocarbons. He studied chemical engineering at USC, California Tech and Yale.

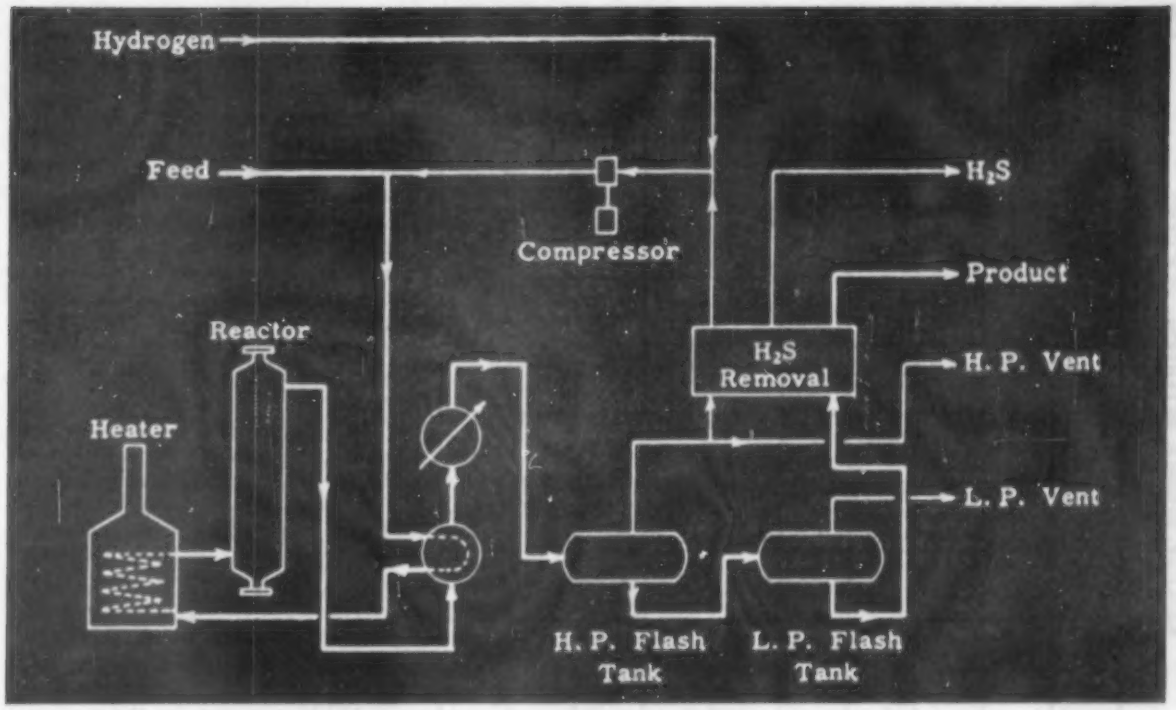

FIGURE 1—Flow sketch of selective hydrodesulfurization: Four principal feed stocks have been processed.

sure separator is first flashed at a low pressure in order to remove part of the dissolved gases, and is then treated so as to remove hydrogen sulfide. A final caustic and water wash removes last traces of hydrogen sulfide.

Construction Materials for Hydrodesulfurization Plants—Materials of construction for this type of plant should be adequate to resist the effects of hydrogen and hydrogen sulfide. Chromium and molybdenum in low concentrations are effective in preventing hydrogen damage at the pressures and temperatures used. Higher chromium steels may be required in certain parts of the plant to resist corrosive action by hydrogen sulfide.

Operation — Four principal feed stocks have been processed. These are: (1) C_5 or C_6 at 310-F, catalytically cracked naphtha; (2) 250 to 430-F, catalytically cracked naphtha; (3) 200 to 420-F, thermally cracked naphtha; and, (4) light straight-run distillates. The cracked fractions are obtained from Los Angeles Basin-Ventura and West Texas crude-oil sources. The intermediates are obtained from high-sulfur West Texas crude oils. A fifth stock charged to the Dominguez unit during the war was a stove-cracked distillate, a by-product from butadiene manufacturing operations. It was hydrodesulfurized in order to make it suitable for blending into aviation gasoline.

The feed is vaporized before it comes in contact with the catalyst. Normal operating pressure is between 500 and 750 psig. The reactor inlet temperature, which is normally between 450 and 650-F, is determined by (a) the boiling range of the feed stock, (b) the depth of desulfurization required, and (c) the amount of time since the last catalyst regeneration. Because the hydrogenation reaction is exothermic, there is a temperature rise through the reactor. High liquid hourly space velocities are possible, and they allow the use of a small reactor. Mole ratio of hydrogen to feed is relatively low.

This combination of operating conditions results in long operating cycles. For example, the catalyst is regenerated only once in 2 to 4 months if cracked naphtha is the feed stock. Desulfurization of a straight-run distillate by the Shell process results in operating periods of approximately 10 months between regenerations.

Operating experience at Dominguez, where cracked naphthas are processed, indicates that utlimate catalyst life is limited only by the disintegration of the catalyst. Catalyst usage at this plant amounts to approximately 1 pound for each 600 barrels of cracked naphtha processed.

Catalyst Selectivity — In all this work Shell Oil Company has used a tungsten-nickel-sulfide catalyst. It has high activity and can be regenerated. It is selective. It can be used to desulfurize and to saturate olefins without hydrogenating aromatics. Despite its ability to catalyze hydrogenation of olefins, it has been used successfully for the selective desulfurization of cracked naphtha for motor gasoline. In this case saturation of olefins must be minimized if high octane rating by ASTM research method D 908* is to be retained.

The relationship between sulfur retention and bromine-number retention is shown in Figure 2. This curve is based on test data resulting from nearly 10 years of commercial operation. At 40-percent sulfur retention, the bromine-number retention is approximately 70 percent. This single curve represents the average selectivity of fresh and used tungsten-nickel-

* Hereinafter octane-number designations refer to ASTM methods.

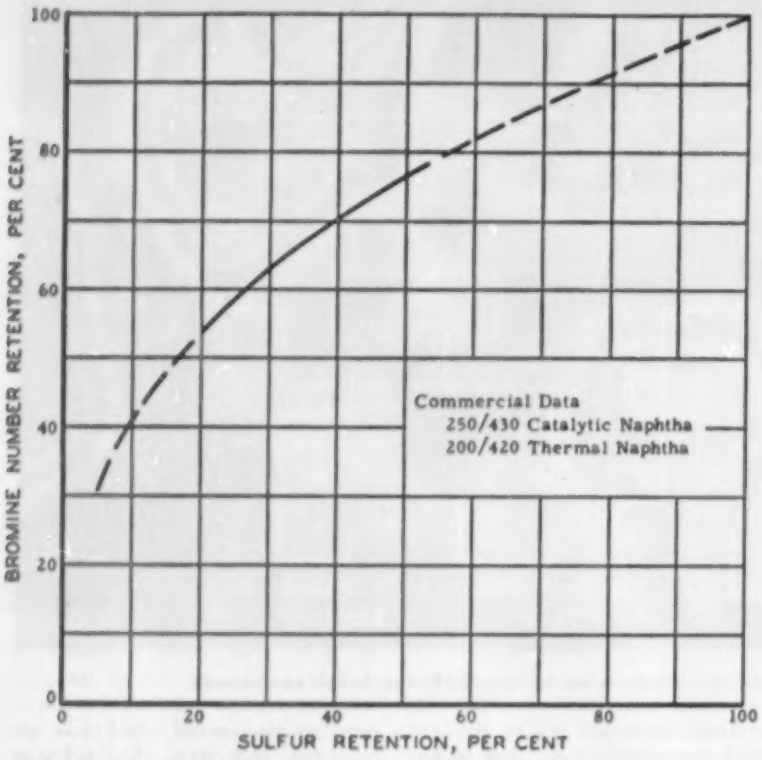

FIGURE 2—Selectivity of the catalyst when hydrodesulfurizing thermally and catalytically cracked naphthas.

sulfide catalysts treating both thermally and catalytically cracked fractions from Los Angeles Basin crude oils (sulfur content: 0.4 to 1.2 percent by weight; bromine number: 40 to 90).

Product Properties — Typical feed and product properties are shown in Table 1. Volumetric liquid-product yields are 100 percent, or greater, for all operations. Sulfur reduction from 0.28 to 0.003 percent by weight is obtained in the aviation-base-stock operation. In the motor-fuel operation sulfur is reduced from 0.5 to 0.2 percent by weight while charging catalytically cracked naphtha, and from 1.15 to 0.4 percent by weight while charging thermally cracked naphtha. In the light straight-run intermediate operation the sulfur is reduced from 0.45 to 0.10 percent by weight, or less. The percent reduction in sulfur for these four operations varies from 60 to 99 percent.

Mercaptan sulfur is more easily removed by hydrogenation than ring sulfur. For example, in the data shown for light straight-run intermediates the mercaptan-sulfur reduction was over 98 percent, whereas the total sulfur reduction was 75 to 80 percent. Doctor-sweet products are not normally obtained from this process; however, products such as treated heavy catalytically cracked naphtha are odor sweet.

Bromine numbers are reduced severely when deep desulfurization is required. This is illustrated by the aviation-base-stock operation in which the bromine number is reduced from 72 to 9. Bromine-number reductions for the motor-fuel operations are less severe. Here the drop is only from 45 to 33 and from 71 to 48 for the catalytically cracked and thermally cracked naphtha operations, respectively.

Conjugated diolefins are, for the most part, removed. This is shown by the low maleic anhydride value of 0.1 to 1.2 for the various products. Percent maleic-anhydride-value reduction varies from 96 to 99.7 percent.

The selectivity of the catalyst is further evidenced by the fact that there is little or no reduction in aromatics in any of these operations.

ASTM gum tests on the products are consistently good; the test value for each operation is 1 mg per 100 ml. Induction-period tests consistently run over 24 hours.

Two things should be noted from the ASTM boiling ranges. First, no cracking occurs in this operation. The slight decrease in the initial boiling point is caused by the breaking of sulfur-containing molecules, which

TABLE 1
Feed and Product Properties
(Selective Hydrodesulfurization of Cracked Naphthas and Straight-Run Intermediates)

	AVIATION BASE STOCK		MOTOR FUEL				MINERAL SPIRITS KEROSINE		
FEED	Catalytically Cracked Naphtha		Catalytically Cracked Naphtha		Thermally Cracked Naphtha		Light Straight-Run Intermediates		
Crude Source	Los Angeles Basin		Los Angeles Basin		Los Angeles Basin		West Texas		
Operation:									
Hydrogen consumed, cf per bbl	500		110 to 175		200 to 250		65		
Length of process period before regeneration required, months	3 to 4		2 to 3		2 to 3		10		
	Feed	Product	Feed	Product	Feed	Product	Feed	Product	
Yield and Properties of Feed and Products:									
Liquid yields, percent by volume	100	102	100	101	100	101	100	100	
Total sulfur, percent by weight	0.28	0.003	0.50	0.20	1.15	0.40	0.45	0.10	
Mercaptan sulfur, percent by weight			0.002	0.003	0.02	0.006	0.07	0.001	
Bromine No., grams per 100 g	72	9	45	33	71	48	.....	.....	
Maleic anhydride value, mg per gram	30	0.1	20	1.2	28	1.0	.....	.....	
Aromatics, percent by weight	33	33	41	41	11	11	.....	.....	
ASTM gum, mg per 100 ml	.....	1	3	1	.....	1	.....	.....	
Copper-dish gum, mg per 100 ml	.....	2	560	27	240	18	.....	.....	
Induction period, hours	.....	.....	.....	24+	.....	24+	.....	.....	
Blending octane numbers, ASTM method:									
D 614 aviation (with addition of 4.6 ml TEL)	76	96	.....	.....	.....	.....	.....	.....	
D 909 supercharge index (with addition of 4.6 ml TEL)	.....	125	.....	.....	.....	.....	.....	.....	
								Mineral Spirits	Prime White
ASTM Distillation, Degrees Fahrenheit:									
Initial boiling point	152	141	286	283	228	221	320	315	380
50-percent point	232	227	348	348	300	296	410	341	429
Dry point	297	298	.....	.....	.....	.....	.....	.....	.....
Final boiling point	.....	.....	427	431	416	417	515	383	530

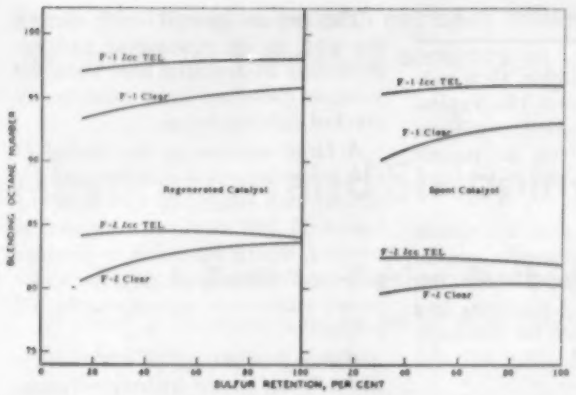

FIGURE 3—Octane number of hydrogenated 250 F. to 430 F. catalytic naphtha.

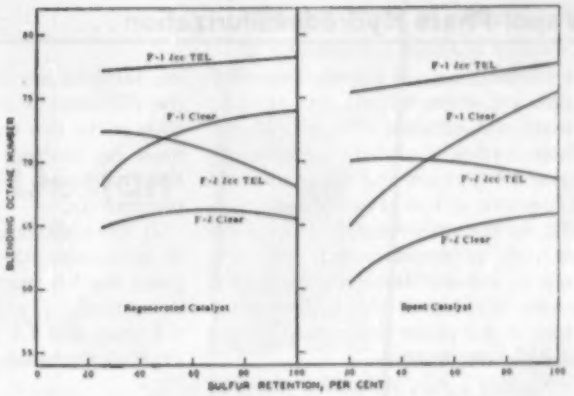

FIGURE 4—Octane number of hydrogenated 200 F. to 420 F. thermal naphtha.

gives materials of lower boiling point. Second, there is essentially no change in dry point or final boiling point. Therefore, no rerunning is required.

The leaded D 614 aviation octane number of the aviation base stock rises sharply from 76 to 96. The D 909 supercharge octane number is essentially unchanged. Octane numbers for the motor-fuel operations are shown in Figures 3 and 4. (Octane numbers "F-1" and "F-2" in these graphs refer to "ASTM research method D 908" and "ASTM motor method D 357," respectively.) These curves represent the result of four series of tests. Figure 3 shows results obtained with 250 to 430-F. catalytically cracked naphtha, with catalysts of different ages, during desulfurization to different degrees. Figure 4 gives similar data for 200 to 420-F. thermally cracked naphtha. The curves indicate a slight decrease in the leaded D 908 research blending octane number and a sharper decrease in the clear D 908 research blending octane number as sulfur retention is decreased. They also show an increase in the leaded D 357 motor octane number as desulfurization is increased to approximately 70 percent. Beyond this point the curves fall off. There may or may not be a slight rise in the clear D 357 motor octane-number curves but, in general, there is an overall loss at 60 to 70-percent desulfurization.

Comparison of Hydrogenation with Acid Treating—It is of interest to compare the economics of hydrodesulfurization with the competitive process, acid treating. Both sulfuric acid and hydrogenation have been used to treat catalytically cracked and thermally cracked naphthas for removal of sulfur and gum-forming components. Hydrogenation is preferred because of superior yields, despite the fact that it is not quite as selective as acid treating (the D 908 research octane number, with addition of 2 ml TEL, is approximately two numbers higher at equal desulfurization levels of 60 percent). At the same time the color stability and the 10 mg gum time of the acid-treated product is somewhat better. On the other hand, the induction period of hydrogenated product is superior. The products from either process are entirely satisfactory for blending in motor fuel.

Table 2 shows typical capital and operating costs for a hydrodesulfurization plant with a capacity of 10,000 barrels per stream day. Today's replacement cost for a 10,000-barrel-per-stream-day plant such as that at the Dominguez refinery is estimated to be $2 million excluding utilities. This cost assumes adequately fractionated feed stocks delivered to the plant site. Product refractionation is not required. The estimated capital cost is greatly dependent upon location and construction standards. Contracting firms have quoted considerably lower costs than estimated by Shell Development Company for identical plants in similar service. Utilities and chemicals are taken at typical West Coast prices. Hydrogen is priced at fuel value, assuming it is available as a byproduct from, for example, catalytic reforming. Operating experience shows that two men are required to operate such a plant. Maintenance is included at 4 percent of capital per annum. Overhead, which includes taxes, insurance, laboratory services, etc., is assumed to be 7 percent of capital per annum. This gives a total cost of 13.1 cents per barrel for the hydrodesulfurization of catalytically cracked naphtha and 13.5 cents per barrel for thermally cracked naphtha.

TABLE 2
Hydrodesulfurization Capital and Operating Costs
(Plant cost, excluding offsite facilities: $2,000,000. Plant capacity: 10,000 barrels per stream day. Onstream time: 93 percent.)

	Costs (Cents per Barrel)
Utilities	3.2
Chemical and Catalyst	1.1
Hydrogen	0.6*
Labor (including labor benefits)	1.7
Maintenance (labor plus material)	2.4
Overhead (taxes, insurance, laboratory plus other refinery overhead costs)	4.1
Total	13.1*

* For catalytically cracked naphtha. Add 0.4 cents per barrel for thermally cracked naphtha.

An economic comparison of hydrodesulfurization with acid treatment is shown in Table 3. Operating costs are approximately $300 to $500 per day lower for hydrodesulfurization than for acid treating and rerunning, assuming fresh sulfuric acid is available at 1 cent per pound.

When thermally cracked naphtha is acid treated (at the rate of 10 pounds acid per barrel), the yield of finished gasoline blending stock is approximately 87 percent of the original charge, 11 percent is degraded to cutter stock, and approximately 2 percent is lost to the acid layer. Hydrodesulfurization, on the other hand, gives a final yield of approximately 101 percent by volume. The leaded D 908 research octane number of the acid-treated stock is 1.9 points higher than the hydrodesulfurized stock.

When catalytically cracked naph-

tha is acid treated (at the rate of 7 pounds acid per barrel), the gasoline yield is approximately 94 percent, the cutter stock amounts to approximately 4 percent, and approximately 2 percent is lost. Hydrodesulfurization, on the other hand, gives an overall yield of approximately 101 percent by volume. However, the leaded octane number of the hydrogenated stock is 2.3 points lower than on the acid-treated fraction.

Product values are posted prices as of early 1954. An adjustment was made for differences in lead requirements. Thermally cracked naphthas were blended in house-brand gasoline and catalytically cracked naphthas in premium gasoline.

Payout was calculated for two different situations. The first assumes a refinery with acid-treating facilities available. Hydrogenation is then justified only if the total cost of the hydrogenation unit, $2 million, is returned in a reasonable time. The figures show 2.5 years payout (before taxes) for catalytically cracked naphtha feed and 1.6 years for thermally cracked naphtha feed. If, however, neither hydrogenation nor acid-treating facilities are available, then only the difference between the capital costs of the two units, or $1.3 million, must be justified. Here the payout time reduces to 1.6 years and 1 year, respectively.

If spent alkylation acid is available at zero value, the respective payout times are 3.6 years and 2.3 years for catalytically cracked naphthas and 2.1 years and 1.4 years for thermally cracked naphthas.

Summary and Conclusions — The vapor-phase hydrodesulfurization process, with tungsten-nickel-sulfide catalyst at a pressure above 500 psig and temperatures below 700 F., has been proved by approximately 10 years of successful commercial operation. Under these conditions the catalyst is selective for removal of sulfur (including ring sulfur) without cracking or polymerization, gives little aromatics hydrogenation at high space velocities, and saturates essentially all conjugated dienes with a moderate degree of mono-olefin saturation. The catalyst retains its activity for long operating periods (several months) and can be regenerated.

TABLE 3

Economic Evaluation

(Comparison of Hydrodesulfurization and Acid-Treating Costs for Cracked Naphthas)

	250- TO 420-F CATALYTICALLY CRACKED NAPHTHA						200- TO 420-F THERMALLY CRACKED NAPHTHA					
	Hydrodesulfurization			Acid Treating			Hydrodesulfurization			Acid Treating		
Capital cost of 10,000-barrel-per-stream-day plant, excluding utilities and offsites	$2,000,000			$700,000			$2,000,000			$700,000		
	Barrels Per Calendar Day	Dollars Per Barrel	Dollars Per Calendar Day	Barrels Per Calendar Day	Dollars Per Barrel	Dollars Per Calendar Day	Barrels Per Calendar Day	Dollars Per Barrel	Dollars Per Calendar Day	Barrels Per Calendar Day	Dollars Per Barrel	Dollars Per Calendar Day
Operating Costs:												
Treating	9,300	0.131	1,218	9,300	0.12†	1,116	9,300	0.135	1,256	9,300	0.15†	1,395
Redistillation	.....	.....	.....	9,105	0.05	455	.....	.....	.....	9,114	0.05	456
Solutizing	.....	.....	.....	.....	.....	.....	9,393	0.035	329	8,111	0.035	284
Total			1,218			1,571			1,585			2,135
Product Value:												
Naphtha*	9,393	6.13	57,579	8,713	6.13	53,411	9,374	5.50	51,557	9,095	5.50	44,523
Cutter	.....	.....	.....	392	3.36	1,317	.....	.....	.....	1,003	3.36	3,370
TEL credit (debit)	.....	0.03	282	.....	0.15	1,307	.....	(0.28)	(2,625)	.....	(0.24)	(1,943)
Total			57,861			56,035			48,932			45,950
Product value less operating cost			56,643			54,464			47,347			43,815
Net advantage for hydrodesulfurization			2,179						3,532			
Payout on total investment on hydrodesulfurization unit ($2,000,000), years			2.5†						1.6†			
Payout on incremental investment ($1,300,000), years			1.6†						1.0†			

* House-brand gasoline at $5.50 per barrel and premium gasoline at $6.13 per barrel (National Petroleum News, January 6, 1954)

† Includes fresh sulfuric acid at 1 cent per pound: when spent alkylation acid is available at zero value, acid-treating cost is 5 cents per barrel for both catalytically cracked naphtha and thermally cracked naphtha. For catalytically cracked naphtha, the payout times become 3.6 years and 2.3 years for the $2,000,000 and $1,300,000 investments, respectively. For thermally cracked naphtha the payout times become 2.1 years and 1.4 years for the $2,000,000 and $1,300,000 investments, respectively.

The process proved itself, during the war, as an economical tool for producing an aromatic base stock for aviation gasoline from catalytically cracked light naphthas.

A large increase in the leaded D 614 aviation octane number was obtained, with essentially no loss in the leaded D 909 supercharge octane number, during operation to produce a low-sulfur, low-gum product. Volumetric yields were approximately 102 percent.

Although olefin-sulfur selectivity is not a factor in the hydrodesulfurization of light straight-run intermediates, the process has been used in the treatment of these stocks for the production of low-sulfur, good-color, and good-odor mineral spirits and light furnace oil from naphthas derived from sour crude oils. The Shell hydrodesulfurization process,[2] which uses cobalt-molybdenum-alumina catalyst, is equally as satisfactory for treating such stocks, and less capital is required for new facilities.

The most promising applications of tungsten-nickel-sulfide catalyst in the field of hydrodesulfurization appear to be in the selective desulfurization of cracked naphthas containing 0.4 to 1.5 percent by weight of sulfur in order to make them suitable for motor-fuel blending. Here commercial application has been successful in reducing sulfur approximately 60 to 70 percent, with only a small decrease in the leaded D 908 research octane number, but with a corresponding increase in the leaded D 357 motor rating, while producing a stable gasoline in all respects. Because of the high yield of treated naphtha (100 percent by volume, plus), the process is economically attractive compared to conventional acid treating, in which losses to acid and polymerization to higher boiling components are encountered.

Original presentation was before the API Division of Refining midyear meeting, St. Louis, May 11, 1955.

ACKNOWLEDGMENT

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From the files of a process engineer comes this method for engineering accuracy in . . .

Absorption and Stripping Design

Part 1. Basis for Design Method

Part 2. Example Calculation for Absorption System

Part 3. Example Calculation for Stripping System

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Dallas, Texas

IN THE ACTUAL operation of an absorption plant, the performances of the absorption and stripping systems are dependent on each other. However, in design, the two systems are usually treated separately. In this series is presented an explanation and example of the application of a process design method with engineering accuracy by considering the hydrocarbon absorption and stripping systems as one unit.

In the several articles on these design methods,[1, 2, 3, 4, 5] the authors have treated the absorption and stripping processes as separate units (in order to simplify the illustration of the design method application). Though no attempt is made here to repeat the detailed derivation and discussion of the various design methods, a brief review of the basic principles is in order.

Types of Design Methods—In general, there are two types of design methods for absorption and stripping processes. The first type can be classified as graphical design methods and the second as algebraic or analytical design methods. The fundamental principles which form the basis of both types of methods are:

1. The material balance.
2. The energy balance.
3. The phase equilibrium relations.

The differences in the two types of design methods are primarily due to manner of application of these principles and the accompanying modifications and the simplifying assumptions. Because of the differences in the modifying and simplifying assumptions, one design method will provide greater accuracy than the other. At the same time, generally, the more accurate method will be more time consuming than the less accurate method. The design engineer should therefore use his judgment and select the proper design method in order to obtain an answer within the required accuracy. For this article, to illustrate the application of a design method of engineering accuracy, the author has selected an algebraic method. However, some of the features and simplifying assumptions in this method are adopted from the graphical method. A brief review of the graphical method, for a better understanding of the application of design method to be presented herein, will be in order.

Graphical Method (Theoretical Plate and Key Component Concepts)

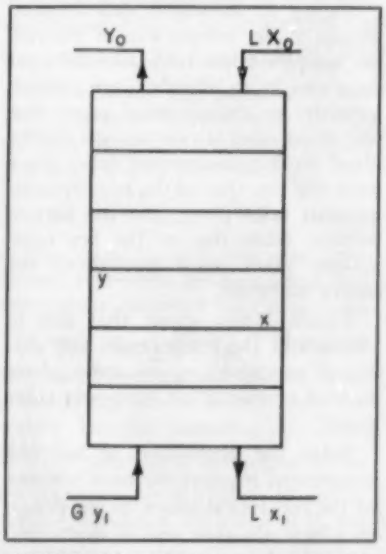

FIGURE 1—Schematic diagram of an absorber.

Meet the Author

R. H. PAREKH, a native of Bombay, India, and now a U. S. citizen, is a chemistry graduate from the University of Bombay and holds a master's degree in chemical engineering from Massachusetts Institute of Technology. Work on a doctorate at the University of Michigan was interrupted by World War II. Except for a year in the U. S. Army, he has been with Magnolia Petroleum Company's Natural Gas department since 1941. His previous experience includes a year with Bahrein Petroleum Company, Ltd., on the Persian Gulf.

—The driving force for absorption in an absorber is directly proportional to the difference between the partial pressure of a component in the gas stream and the equilibrium vapor pressure of the same component in solution with the solvent. This driving force can be represented graphically by the equations of the operating and equilibrium line, in terms of rates and concentrations of vapor and liquid streams in molal stoichiometric units as follows:

By referring to Figure 1, the equation of the operating line is given by

$$L(X_1 - X) = G(Y_1 - Y) \quad (1)$$

or

$$L(X - X_0) = G(Y - Y_0) \quad (2)$$

Where,

X = moles of one solute per mole of solvent
Y = moles of solute in gas phase per mole of inlet gas
L = liquid rate as moles of solute free solvent per unit time
G = gas rate as moles of inlet gas per unit time

Subscripts 1 and 0 refer to the rich and lean end of the absorber, respectively.

The equation of the operating line is based on material balance and it represents the relation between the composition of the gas leaving a plate and the composition of the liquid from the plate above it.

The equation of the equilibrium line can be written as

$$Y = KX\left[\frac{\Sigma Y}{1 + \Sigma X}\right] \quad (3)$$

Where,

ΣY = summation of the values of Y for each component.
ΣX = summation of the value of X for each component, except the solvent present in the liquid phase.

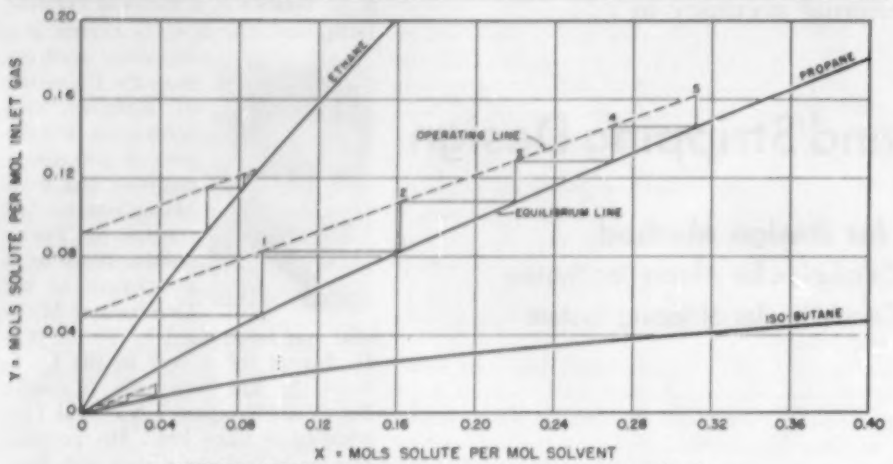

FIGURE 2—X-Y diagram illustrating graphical design for an absorber.

X is unity for the solvent.

K = Equilibrium ratio at the system pressure and temperature = y/x.

The equation of the equilibrium line is based on the theoretical plate concept. It gives the relation between the composition of the gas leaving a plate and the composition of the liquid on the same plate by assuming that the liquid and gas are in equilibrium with each other.

Each component of the inlet gas will have its own operating and equilibrium lines. For each component, these lines can be represented graphically with Y as an ordinate and X as an abscissa.

For the purpose of illustration, a graphical construction of operating and equilibrium lines for ethane, propane and iso-butane for an absorber is shown in Figure 2. The vertical distance at any point between the operating and equilibrium line gives the driving force for absorption in an absorber.

As shown in Figure 2, the operating and equilibrium lines can also be used to determine the required number of theoretical plates. For a given liquid to gas rate, the theoretical plate requirements of different components are different. Among the various components, there is one component which requires the maximum number of theoretical plates. This component is termed as the key component and is defined as that component whose equilibrium line is nearly parallel to the operating line. (As it will be pointed out later under the algebraic method, the key component is that component whose absorption factor "A" is closest to unity.)

For the components more volatile than the key component, the driving force for absorption is greatest at the lean end of the column. The absorption of these components, therefore, takes place in the top section of the absorber.

For the components heavier than the key component, the driving force for absorption is largest at the rich end of the column. The absorption of these components therefore, takes place in the bottom section of the absorber.

The driving force for the key component extends nearly throughout the column and therefore, the absorption of the key component takes place throughout the column.

Figure 3, in which experimental results of the composition of the rich oil samples taken from five different locations in an absorber, are plotted, provides an experimental proof that the absorption of components lighter than the key component takes place near the top, that of the heavier components takes place near the bottom section, while that of the key component takes place throughout the entire absorber.

Figure 3 also shows that due to changes in the temperature and gas-liquid compositions, on some plates instead of absorption, stripping takes place.

Since the absorption of the key component requires the most number of the theoretical plates, in the design of a new absorber and in evaluating the over-all plate efficiency of an absorber in operation, it is pointed out that the number of the theoretical plates should be calculated with reference to the key component. The absorption of components lighter and heavier than the key component is almost independent of the plate efficiency, because for them a relatively large number of plates is always present in an absorber.

The explanation of the graphical method for a stripper is analogous to that of an absorber. In a stripper, the material is transferred from the liquid phase to the vapor phase. The driving force for stripping is directly proportional to the difference between the equilibrium vapor pressure of a component in solution with solvent and the partial pressure of the same component in the gas phase. The injection of the stripping medium such as steam lowers the partial pressure of a component in the gas phase and thereby increases its driving force for stripping at the existing system pressure and temperature.

The driving force for stripping can be represented graphically by the equations of the operating and equilibrium line, in terms of rates and concentrations of vapor and liquid streams in molal stoichiometric units as follows:

By referring to Figure 4, the equation of the operating line is given by

$$L(X_1 - X) = V(Y_1' - Y') \quad (4)$$

or

$$L(X - X_2) = V(Y' - Y_2') \quad (5)$$

and the equation of the equilibrium line is given by:

$$Y' = \frac{KX(1 + \Sigma Y')}{(1 + \Sigma X)} \quad (6)$$

Where,

L = moles of solute free solvent per unit time

V = moles of stripping medium per unit time

X = moles of solute in liquid phase per mole of solute free solvent

Y' = moles of solute in vapor phase per mole of stripping medium

ΣX = summation of the X values in the liquid phase, excluding the solvent

$\Sigma Y'$ = summation of the Y' values in the vapor phase, excluding the stripping medium

K = equilibrium ratio at the system pressure and temperature = y/x.

The subscripts 1 and 0 refer to the rich and lean end of the stripper.

For each component, the operating and equilibrium line can be represented graphically with Y' as an ordinate and X as an abscissa. In the case of stripping, the operating line falls below the equilibrium curve on an X—Y' diagram. The horizontal distance between the operating and equilibrium line at any point represents the magnitude of the stripping driving force. Such a graphical construction can also be used to step off the required number of theoretical plates. Similar to the case of absorption, for one component, whose operating line is very nearly parallel to the equilibrium curve, the number of the theoretical plates stepped off will be the maximum. This component is defined as the key component. The stripping of the components lighter than the key component will occur at the rich end of the stripper. The stripping of the components heavier than the key component will take place at the lean end of the stripper. However, the stripping of the key component will occur mostly along the entire length of the column. The design of a new stripper and the overall performance of a stripper in operation should, therefore, be determined with respect to the key component.

To summarize, the following are the two important deductions derived from the graphical method. First, the key component is the controlling component in the design and performance calculations of the absorption and stripping processes. Second, the fact that absorption of lighter than key components is taking place at the top section of an absorber and that of heavier than key components at the bottom, can be used to estimate the temperature of the top and bottom trays. This will be explained in detail later.

Algebraic or Analytical Method—

a. *For Absorption Design:*

The algebraic equation of Kremser-Brown[1,2] for absorption, when modified to allow for the variations in the liquid and gas rates through the column due to absorption, can be written in molal stoichrometric units as follows:

$$\frac{Y_1 - Y_0}{Y_1 - \left[\frac{K\Sigma Y_0 X_0}{1+\Sigma X_0}\right]} = \frac{\left[\frac{L(1+\Sigma X)}{KG\Sigma Y}\right]^{n+1} - \left[\frac{L(1+\Sigma X)}{KG\Sigma Y}\right]}{\left[\frac{L(1+\Sigma X)}{KG\Sigma Y}\right]^{n+1} - 1} \quad (7)$$

Where n represents the number of theoretical trays.

The above algebraic equation is used by the author in this article to illustrate the application of process design method of engineering accuracy for an absorber.

The left hand term in the above equation represents the efficiency of absorption and it is designated by the symbol Ea. The term $\frac{L(1+\Sigma X)}{KG\Sigma Y}$ is defined as the absorption factor and it is designated by symbol A. By substituting the above symbols, Equation 7 is simplified to the following:

$$Ea = \frac{(A)^{n+1} - (A)}{(A)^{n+1} - 1} \quad (8)$$

The term $Y_1 - Y_0$ for any component represents the amount of that component absorbed by the solvent. The term $Y_1 - \left[\frac{K\Sigma Y_0 X_0}{1+\Sigma X_0}\right]$ represents the maximum amount of any component that can be theoretically absorbed by the solvent. The term $\frac{K\Sigma Y_0 X_0}{1+\Sigma X_0}$ provides a correction factor for the presence of a solute in the incoming solvent. If the value of X_0 for a component is zero, $\frac{K\Sigma Y_0 X_0}{1+\Sigma X_0}$ for that component becomes zero. In this case, absorption efficiency becomes identical to mole fraction absorbed. When X_0 is not zero, as in the case of partially stripped lean oil, the absorption efficiency and mole fraction absorbed for that component are not identical. In order to evaluate this term, it is necessary to know the equilibrium ratio (K) of any component corresponding to the top tray temperature and pressure, the total number of moles of residue gas (ΣY_0) and the mole fraction of the same component $\frac{X_0}{1+\Sigma X_0}$ in the incoming solvent.

Oftentimes, to simplify the absorber calculations, it is assumed that the lean oil is completely stripped, i.e., the value of $\frac{K\Sigma Y_0 X_0}{1+\Sigma X_0}$ is assumed equal to zero. This does not introduce any serious error so far as the absorber calculations are concerned. However, in order to determine the optimum stripping requirement of the stripping system, the term $\frac{K\Sigma Y_0 X_0}{1+\Sigma X_0}$ is very important. It should be included in the process design calculations for an absorption plant, because the performances of absorption and stripping systems are dependent on each other.

The term defined as the absorption factor A contains three variables, namely, the liquid rate (rich oil) $L(1+\Sigma X)$, the gas rate $G\Sigma Y$, and

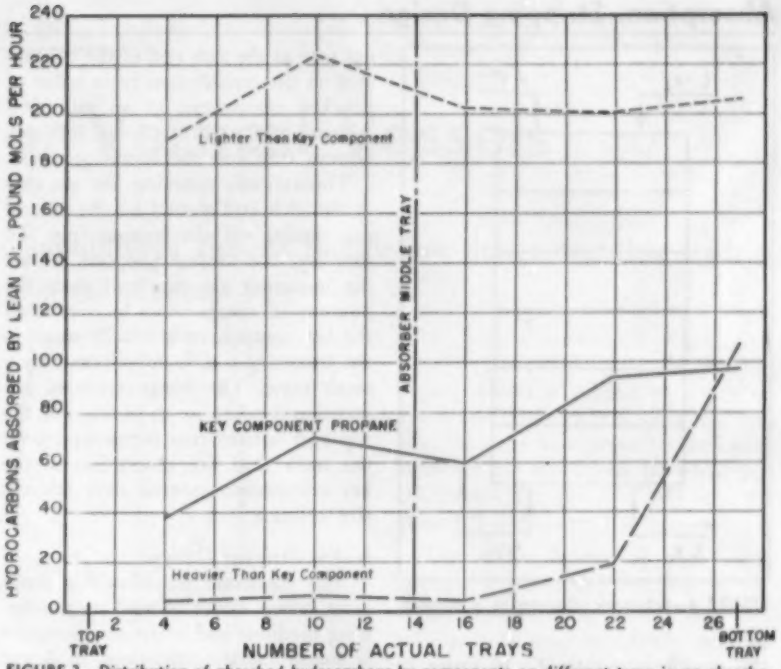

FIGURE 3—Distribution of absorbed hydrocarbons by components on different trays in an absorber (Basis: 730 psig and 113 F.)

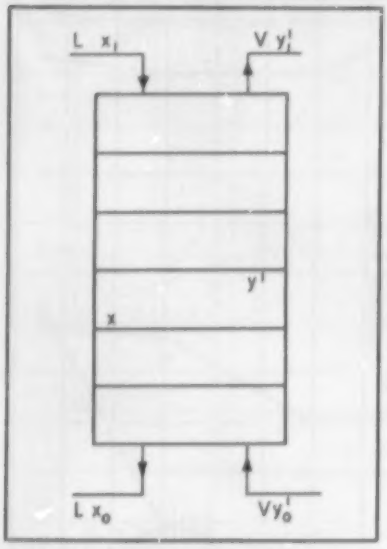

FIGURE 4—Schematic diagram of a stripper.

the equilibrium ratio K. In order to calculate A, from a theoretical point, the values of the above three variables should be taken as a point function in the column. Because of the changes that occur due to absorption, in the gas and liquid rates, as well as in their compositions, and the pressure and temperature from plate to plate, the values of absorption factor A will vary throughout the absorber. The various algebraic methods for the absorber design which have been published[1, 2, 3, 4, 5] differ from each other mostly because of the difference in the assumptions made with regard to the value of A to be used in the general equation.

It was pointed out under graphical method discussion and was substantiated by experimental results in Figure 3 that the absorption of the key component (the component whose absorption factor is closest to unity) mostly takes place between the top and bottom tray. The experimental results also show that the value of the ratio of liquid and gas rate in the region between the top and bottom tray varies slightly from the value of the ratio of liquid and gas rate at the rich end of the column. Except in the case of a few unusual cases, the above observation is generally found to hold good.

For engineering accuracy, therefore, the author has proposed to calculate an average value of A for the key component based on the liquid and gas rate at the rich end of the column and on the equilibrium ratio value of the key component at an estimated average temperature of the top and bottom tray and the system pressure.

Theoretically speaking, the gas rate at the rich end should be the rate of gas coming off the bottom tray. To simplify, the author proposes to use the incoming gas rate and since the amount of components heavier than the key component is usually small in the incoming gas, it introduces only a small error. The temperature of absorption is taken as an average of the top and bottom tray temperatures on the basis that the absorption of the key component extends over the entire column.

b. *For Stripper Design:*

The algebraic equation for stripping, when steam is used as a stripping medium and when an allowance is made for the variations in liquid and vapor rate due to stripping, can be written in terms of molal stoichiometric units as follows:

$$\frac{X_1 - X_0}{X_1} = \frac{\left[\frac{KV(1+\Sigma Y^1)}{L(1+\Sigma X)}\right]^{n+1} - \left[\frac{KV(1+\Sigma Y^1)}{L(1+\Sigma X)}\right]}{\left[\frac{KV(1+\Sigma Y^1)}{L(1+\Sigma X)}\right]^{n+1} - 1} \qquad (9)$$

The term on the left hand side of the above equation represents the stripping efficiency and is designated by the symbol Es. The term $\frac{KV(1+\Sigma Y^1)}{L(1+\Sigma X)}$ is defined as the stripping factor and is designated by symbol S. By substituting these values, Equation 9 is simplified to the following:

$$Es = \frac{[S]^{n+1} - [S]}{[S]^{n+1} - 1} \qquad (10)$$

The term $X_1 - X_0$ represents the amount of any component which is stripped by the stripping medium.

The stripping factor term S contains three variables, namely, the equilibrium ratio K, the vapor rate $V(1 + \Sigma Y^1)$ and the liquid rate $L(1 + \Sigma X)$. Theoretically speaking, the values of the above variables should be taken as a point function in the stripper. Because of the stripping, the values of these variables will change from plate to plate.

For the example of application of the stripping design method of an engineering accuracy, an average stripping factor is calculated for the key component, the component whose stripping factor is closest to unity, based on the vapor and liquid rates at the rich end of the stripper and the equilibrium ratio value at an average temperature of rich and lean end and the system pressure.

In the actual operation of the stripping system, generally, a large portion of the absorbed hydrocarbons is released from the rich oil by preheating it to some high temperature. The flashed (rich oil) liquid at the high temperature is therefore considered as the feed to the stripper. The energy required for the stripping is usually derived from the sensible heat of the preheated rich oil. The injection of stripping medium lowers the partial pressure of the various components in the vapor phase so that the required stripping will occur at the existing temperature and pressure level of the stripper.

When steam is used as a stripping medium, a portion of it is absorbed by the absorption oil. For a given stripping steam rate, the maximum quantity of steam that can dissolve in the oil is dependent on the stripper bottom temperature, pressure and the quantity of absorption oil. Since the operating temperatures of most of the strippers range between 300 and 500 F., the quantity of steam going in solution with the absorption oil becomes of considerable magnitude when the stripper pressure is 75 psia or more. For a design method of an engineering accuracy, the stripping steam rate is first calculated, from Equation (9), by assuming that there is no solution of steam in the absorption oil. Then by using an average value of Henry's Law constant for absorption oil-steam system, the maximum quantity of steam going in solution is calculated for the stripper bottom temperature, pressure, and absorption oil rate, by assuming that the absorption oil leaves the stripper at its bubble point with respect to dissolved steam. The actual stripping steam requirement is then estimated by adding the amount of steam going in solution to that calculated by the use of stripping Equation (9).

In the actual operation of the stripping system, the stripper is generally combined with a rectifying section. The design calculations of the stripping system therefore, becomes somewhat more involved than the design calculations for the stripper only.

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New Techniques in Design of . . .

Foundations for Vertical Vessels

Here are hitherto unpublished tips on foundation design together with a complete treatment of this type of foundation.

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THE MOST COMMON structural problem met with in the design of refineries is that of foundations for vertical vessels. These vessels are cylindrical, and are frequently of considerable height with a large slenderness ratio. The vessel is generally supported on a steel skirt, with a base ring which rests on the concrete of the pedestal. Anchor bolts, with or without supporting lugs, pass through the base ring, and hold the vessel in position, as well as resisting uplift from lateral loads. This article deals with foundations for this type of vessel. The general principles are explained, and illustrated with complete calculations for a typical vessel.

1. Loads

The loads to be considered are as follows:

(a) The dead weight of the vessel itself. This includes the steel shell, trays and other internals, insulation, if any, ladders, platforms and loads from attached piping.

(b) The weight of the liquid in the vessel during operation.

(c) The weight of water in the vessel, when filled for making the hydrostatic test.

The above are vertical loads. The empty weight, (a), is combined with the lateral load to determine the maximum uplift to be resisted by the anchor bolts. The operating weight, (a + b), combined with lateral loads, generally determines the design of the footing itself. The test load, (a + c), is used without lateral loads, and will frequently produce the maximum pressure on the soil. It must be considered in any event, unless there is definite assurance that a hydrostatic test will not be made in the field.

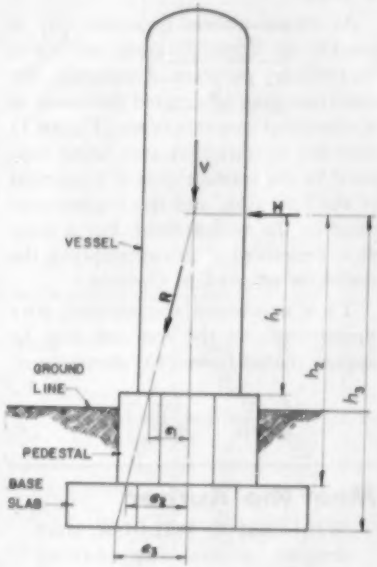


FIGURE 1

(d) The lateral load, in any horizontal direction, due to wind pressure. The wind is assumed as a horizontal force upon the entire projected area of the vessel. A formula commonly used is

$$P = .0032\ V^2$$

where P is the pressure in pounds per square foot, and V is the velocity of the wind in miles per hour. Thus, for a wind with a velocity of 100 miles per hour, the pressure would be 32 pounds per square foot. The value to be used depends on the applicable local building codes, or upon the preference of the customer, or lacking these, on the judgment of the designer. The range is from 15 to 20 pounds on the Pacific Coast, 30 pounds in the East and Middle West, to 45 pounds or more on the Gulf Coast, which is subject to winds of hurricane intensity. For very tall vessels, the code may prescribe increased intensity for the upper portions; say 30 pounds for the first 100 feet, 40 pounds for the next 100 feet, etc.

The above figures are for wind against a plane surface. For a cylindrical surface the load is less, the common figure being 60 percent (sometimes taken as two-thirds).

The effective diameter of the vessel for figuring wind load is taken as the outside diameter of the insulation, plus 20 percent to allow for ladders, platforms and attached piping.

(e) The lateral load, in any horizontal direction, due to seismic (earthquake) effects. This is taken as a percentage of the dead load; the amount varying, for different locations and codes, from 3 percent to 20 percent of the dead load. It is considered as applied at the center of gravity of the dead load; or separately, at the centers of gravity of the several portions of the dead load. Once determined, it is treated in the same manner as a wind load. Wind load and seismic load are not considered as occurring at the same time; either one may be the critical loading for the vessel.

(f) In large vessels, with large diameter piping attached, the thrusts of the piping from thermal expansion may need to be considered. Ordinarily, however, these effects are relatively small, and may be disregarded.

(g) It is at times necessary to consider the loadings imposed upon the foundation during the erection of the vessel, both from the vessel and from the erection equipment. Large vessels are frequently erected by means of a

gin-pole on each side; the base slab of the foundation may then furnish the temporary support for the gin-poles.

(h) The weight of the concrete in the pedestal and base slab, and the earth on top of the base, are loads to be considered in determining the maximum soil pressure, and the design of the base slab.

2. Features of Design

Assuming that the vessel itself has been previously designed, the structural designer must consider three items: (1) the anchor bolts; (2) the pedestal; (3) the base slab.

The general arrangement of vessel and loads is shown in Figure 1. The vertical load, V, centered on the vessel, and the lateral load H, can be combined to form an inclined resultant, R. This force R strikes the plane of the bottom of the vessel at a distance e_1 from the center. At the bottom of pedestal the distance is e_2, and at the bottom of base it is e_3. These distances e are known as the eccentricity. In each case we have the relation V × e equals the overturning moment; that is, the horizontal force H multiplied by the vertical distance h from the point of application of H to the plane in question. The effect is the same as if the load V were moved out from the center of the vessel the distance e.

3. Anchor Bolts

The anchor bolts are usually designed by the following approximate method, which is sufficiently accurate for the ordinary case:

Figure 2a represents a horizontal section, and figure 2b a vertical section, of the bottom of skirt and base ring. If D is the diameter of the skirt in inches, the direct compression in the skirt, from the vertical load V, per inch of skirt, is $V/\pi D$. The overturning moment M, (Hh or Ve), produces a compression on the leeward side and a tension on the windward side, the maximum value of which, per inch of skirt, is $M/\frac{1}{4}\pi D^2$. We have, then,

Maximum load per inch on leeward side

$$\frac{V}{\pi D} + \frac{4M}{\pi D^2} \qquad (1)$$

Minimum load per inch on windward side

$$\frac{V}{\pi D} - \frac{4M}{\pi D^2} \qquad (2)$$

When expression (2) is negative, anchor bolts are required to resist the uplift. If there are N anchor bolts equally spaced around the circle, each takes load from $\pi D/N$ inches of skirt; and the load on one bolt (tension) is

$$T = \frac{4M}{DN} - \frac{V}{N} \qquad (3)$$

In the application of formula (3), D is usually taken as the diameter of the anchor bolt circle, which may be a few inches more than the diameter of skirt.

As stated above, Equation (3) is frankly an approximation, sufficient for ordinary purposes. Accurately, the condition may be treated the same as a reinforced concrete beam (Figure 3) with the compression area being supplied by the contact area of a segment of the base ring, and the tension supplied by the anchor bolts. For a complete treatment of this assumption, the reader is referred to Gartner.[1]

The maximum compression per square inch on the concrete may be approximated from (1), above, as

$$\left[\frac{V}{\pi D} + \frac{4M}{\pi D^2}\right] \div B \qquad (4)$$

where B is the width of the base ring in inches. This compression will ordinarily be much less than the permissible value.

It may be noted here that it is normally permissible, for a combination of vertical and lateral loads, to use unit stresses in concrete and steel one-third greater than those permitted for vertical loads alone.

Anchor bolts are generally of the L type or the J type, as shown in Table 1. The effective area for tension is the area at the root of thread.

Light weight metal sleeves are provided at the top of the concrete to permit adjustment. These sleeves increase in diameter and length as the bolt size increases. Sleeve sizes are given in Table 1.

The tension in the bolt is transmitted to the concrete in the length of bolt below the sleeve, and in the hooked portion for J-bolts.

The allowable tension in anchor bolts permitted by different codes varies from a minimum of 12000 psi to a maximum of 26700 psi (20000 + 1/3 increase for a combination of vertical and lateral loads). Recent experience with vessels subjected to earthquake shocks has shown that the bolt may be definitely stretched, and the bond between the steel and the concrete may be broken, by the vibratory shock action of the earthquake. The same is possible, in somewhat lesser degree, from high wind loads. Since the cost of anchor bolts is a negligible proportion of the total cost of the installation, it is good practice to design them conservatively.

The bolt schedule in Table 1 is based on a unit stress of 15,000 psi at root of thread. The bond of steel to concrete is taken as 135 psi for 3000 pounds concrete, or 112 psi for 2500 pounds concrete. For L-shaped bolts, no extra value is given to the bend, but the bond is figured on the total length below the sleeve. For J-shaped bolts, the hook is assumed to develop a value of 7500 psi on the gross area of the bolt, and the remainder of the load is taken in bond on the portion between the tangent point of the hook and the bottom of the sleeve. On account of their better performance, J bolts are recommended for general service; L bolts may be used for light loads, or where the size of the bolt is

Meet the Author

WILLIAM E. WILBUR, chief designer, general engineering division of Fluor Corporation, Ltd., has spent most of his career either in bridges or refineries. Associated with a Kansas City firm of bridge builders for 14 years before he joined the Fluor organization in 1942, he has filled two 250-page notebooks with problems he faced in structural engineering. One book is devoted to bridges, the other to refineries. With the problems, he has recorded their solutions so he would never have to work them out again. A licensed engineer in Illinois, Missouri and California, Wilbur is a 1911 civil engineering graduate from Iowa State College, and he is a life-member of ASCE.

considerably greater than the minimum required.

Some codes require an increase in the diameter of the bolt to allow for possible corrosion. In such case, the diameter is determined from the required net area, and the size is then increased by the amount of the corrosion allowance (usually 1/8 inch).

When the vessel is placed, the nuts on the anchor bolts are tightened until the bolts are in tension. There appears to be some misunderstanding as to the effect of this initial tension on the maximum bolt stress. The initial tension in the bolt causes an equal compression between the base plate and the concrete. When the uplift is then applied, part of the uplift increases the tension in the bolt, but part relieves the compression on the concrete. When the uplift has become great enough to relieve all the compression on the concrete, the stress in the bolt is just what it would have been had there been no initial tension. Initial tension does not, therefore, act to increase the maximum tension in the bolt.

4. The Pedestal

The concrete pedestal, which directly supports the vessel skirt, extends from a short distance above the ground to the top of the concrete base slab. It is generally octagonal in shape. Its size should be such as to accommodate the anchor bolts, as well as to support the entire base ring. Generally this will require a dimension, across the flats, about 18 inches greater than the diameter of the vessel. Good practice requires that the anchor bolt sleeves lie within the main vertical reinforcement; this will call for about 4 inches from center of bolt to edge of concrete.

It is preferable that the anchor bolts shall be entirely in the pedestal; that is, they should not extend into the base slab. It is difficult to set the bolts and hold them accurately in place while the base slab is being poured; whereas after the base is complete, it is simple to support the bolts by a templet from the side forms of the pedestal.

The critical point for design of the pedestal is at the top of the base slab. The vertical load is the weight of the vessel and contents, plus the weight of the pedestal. The overturning moment is H h_2. The design is made on the basis of a reinforced concrete beam subject to bending and direct stress. Except for the largest vessels, the stress in the concrete will be very low, and the design is therefore principally concerned with the amount of tensile reinforcement, which itself is likely to be very small.

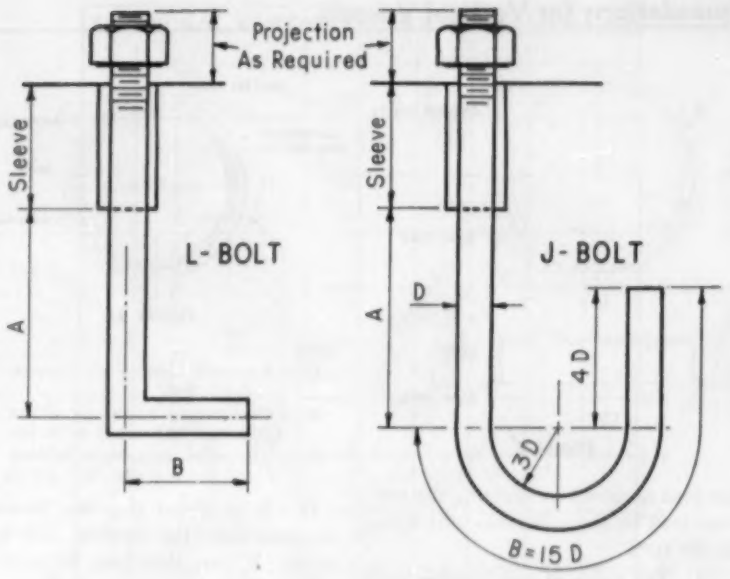


TABLE 1
Anchor Bolts (See sketch above)

TYPE	Size	Net Area Sq. In.	Max. Load Kips	Lengths, Inches			Sleeve
				A_1	A_2	B	
L	¾	.302	4.5	14	11	3	2" Diam. x 6
	⅞	.419	6.3	17	13½	3½	2½" Diam. x 12
	1	.551	8.3	20	16	4	2½" Diam. x 12
	1	.551	8.3	7	6	15	2½" Diam. x 12
	1⅛	.693	10.4	7½	6½	17	2½" Diam. x 12
	1¼	.890	13.3	9½	8	19	3" Diam x 18
	1⅜	1.054	15.8	10	8½	20½	3" Diam. x 18
	1½	1.294	19.4	12	10	22½	3" Diam. x 18
J	1⅝	1.515	22.7	12½	10½	24½	3½" Diam. x 18
	1¾	1.744	26.2	13½	11	26½	3½" Diam. x 18
	1⅞	2.049	30.7	15	12½	28	4" Diam. x 18
	2	2.300	34.5	15½	13	30	4" Diam. x 18
	2¼	3.021	45.3	20	16½	34	5" Diam. x 18
	2½	3.716	55.7	21½	18	37½	5" Diam. x 18
	2¾	4.619	69.3	25½	21	41½	6" Diam. x 18
	3	5.621	84.3	29½	24½	45	6" Diam. x 18

A_1 is A length required in 2500-pound concrete.
A_2 is A length required in 3000-pound concrete.

One vertical bar should be placed in each of the eight corners of the octagon. For large structures, additional bars may be placed in each side. It is good practice to turn some of the bars at the top of the pedestal, and extend them horizontally, to prevent cracks at the upper surface.

Because of the low concrete stress, and the small amount of steel involved, a refined analysis is generally not justified. The following approximation is suggested as usually sufficient:

(1) Determine the moment about the center of steel; that is, H h_2, plus the total vertical load multiplied by the distance from the center of pedestal to center of tensile steel.

(2) Analysis of the beam for this moment will give the correct compressive stress in the concrete. Because the concrete stress is low, however, the true value of "j" will be greater than it is for balanced reinforcement. For determining the area of steel, therefore, it is advisable to obtain a correct value of j from one of the commonly published charts.

(3) The area of steel required for the moment is determined by the common formula $A = M \div f_s jd$. From the area so determined, subtract

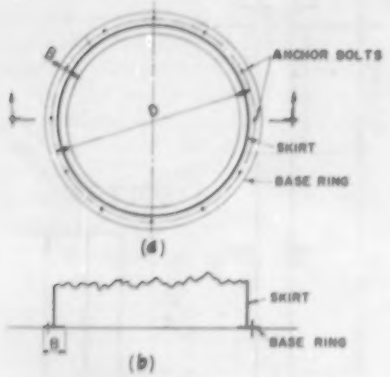


FIGURE 2

the area obtained by dividing the vertical load by the allowable unit stress in the steel.

(4) The value of compressive steel may be ignored. The octagonal beam may be considered equivalent to a rectangular beam with depth equal to the diameter of the octagon across the flats, and width 5/8 of this amount. If there are 8 vertical bars in the pedestal, two may be considered effective as tensile steel. If there are more than 8, equally spaced, ¼ of the total may be considered effective.

(5) It will be found that this method of analysis will sometimes show a very small area of steel required, or even a negative area. This merely means that the steel cannot be used at the unit stress assumed; in this case, a nominal amount of steel is all that is required.

The application of the above rules is shown in the example which follows.

5. The Base Slab

Since the lateral load may come from any direction, the ideal shape for the base slab would be one with equal strength in all directions; that is, a circle. For practical reasons, the octagonal shape is used.

The first step in the design of the base slab is the determination of its size. For a first approximation, two formulas are offered:

(1) For tall, rather narrow vessels, where the lateral load is likely to be the governing factor:—

$$D = 2.6 \sqrt[3]{\frac{M}{F_s}} \qquad (5)$$

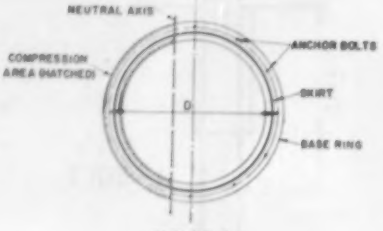


FIGURE 3

where

D = Required diameter (across the flats), feet.

M = Overturning moment about the bottom of base; H h_s, ft. lbs.

F_s = Allowable maximum bearing on soil for this case, lbs. per sq. ft.

It will be noted that this formula does not have the vertical load as a factor. It can therefore be applied without first making an estimate of the size and weight of the footing.

As will be seen in the example following, this formula will give a size of base for which, under extreme lateral load, part of the base area is not under compression. This is permissible in most codes, so long as the factor of safety against overturning is sufficient. If, as required by some codes, the entire base must be under compression, which means that the eccentricity e_s must not be more than 1/8D, then the factor 2.6 above must be increased to at least 2.7.

(2) For relatively short, wide vessels, where the governing condition is likely to be that when the vessel is filled with water for the hydrostatic test:

$$D = 1.25 \sqrt{\frac{V}{F_s - G}} \qquad (6)$$

where

D = Required diameter across the flats, feet

V = Vertical load due to the vessel and its contents, (a + b) or (a + c), lbs.

F_s = Allowable maximum pressure on the soil for this case, lbs. per sq. ft.

G = Weight per square foot of base and earth above it, lbs. per sq. ft.

For this it is necessary to assume a thickness of slab, but great refinement is not required, since a greater thickness of base means a smaller weight of earth, and the net difference is slight.

It is well, in any case, to apply both of the above formulas, and to use the larger value of D so determined. It is, of course, necessary to test the value so chosen by actual computation of the maximum base pressure; but the final size will rarely vary by more than six inches from that determined by the formulas. For preliminary estimates, the results given by the formulas are usually sufficient.

When the size of base has been determined, the next step is to calculate the actual maximum base pressure under the critical load. The vertical load, V, includes the vessel and contents, also the weight of the pedestal and base slab, and earth on top of the base. The eccentricity, e_s, is the overturning moment, H h_s, divided by V. When e_s exceeds 0.127 D, a portion of the base will not be under compression. The factor of safety against overturning is D / 2e. This is required by most codes to be 1.5 or 2.0. If the size of base has been determined by formula (5), above, the factor of safety will be well above this limit. For the case of the vessel under hydrostatic test, no lateral load is assumed to be acting, and the base pressure is therefore uniform over the entire area.

For determining the maximum base pressure, Figure 4 has been prepared. Two cases are to be considered:—

(a) The lateral load acts at right-angles to a diagonal from one corner to the opposite corner. This case gives the maximum intensity of base pressure, which occurs at the corner farthest from the diagonal.

(b) The lateral load acts parallel to one side. For this case, the base pressure is uniform along the entire length of the side which is opposite to the point of application of the lateral load. This pressure is slightly less than that determined from case (a); but this is the figure to be used in the actual design of the slab.

To determine the base pressures for the two cases, enter Figure 4 with the proper value of e/D and proceed vertically to the curve marked L for the case considered. From this intersection, proceed horizontally, and read the correct value of L from the scale on the margin. The value of F, maximum base pressure, is then

$$F = LV/A \qquad (7)$$

where

V = The total vertical load, lbs.

A = The area of the octagon in square feet.

Using the same diagram, proceed upward from this givn value of e/D, to the curve marked K for the given case, and read the actual value of K from the scale on the margin. The distance KD is the length from the windward side of the base to the point of zero base pressure.

With F and KD known, the diagram of the actual base pressure may be drawn.

For the actual design of the base slab, the practice used by various designers is not uniform. Reinforcing may be two-way, four-way, or radial. A considerable experience in this type of design, and an extensive investigation of theoretical formulas, has led to the following recommended practice:

(1) Using the base pressure as determined from case (b), above, find the bending moment for a strip one foot wide, figuring the base as a cantilever from the edge of the pedestal to the outside of the base. Take 85 per cent of this moment for the design of base, and 85 per cent of the shear in determining the bond on the steel. This is the procedure that is specified by the ACI Code for rectangular footings.

(2) On the above basis, determine the amount of reinforcement per foot of width. Provide a reinforcement of this amount, equally spaced, in two directions at right angles to each other, and parallel to the sides, over the entire area of base. Theoretical formulas show that moments perpendicular to those figured may be of considerable magnitude, particularly in the regions close to the edge of the pedestal; the procedure outlined provides for this condition.

(3) The shear will seldom be a determining factor, since it is good practice to save steel by using a liberal thickness of base. The maximum shear occurs at a distance from the face of the pedestal equal to the net depth of the base slab; the assumptions used are shown in Figure 5. Shear reinforcement is not used in bases of this type; hence the base thickness must be sufficient without shear reinforcement.

(4) It is sometimes necessary to consider the possibility of top reinforcing, due to the condition on the windward side of the base, where the downward load, consisting of the weight of the footing and the earth above, produces a greater moment than the small amount of earth reaction beyond the edge of the pedestal.

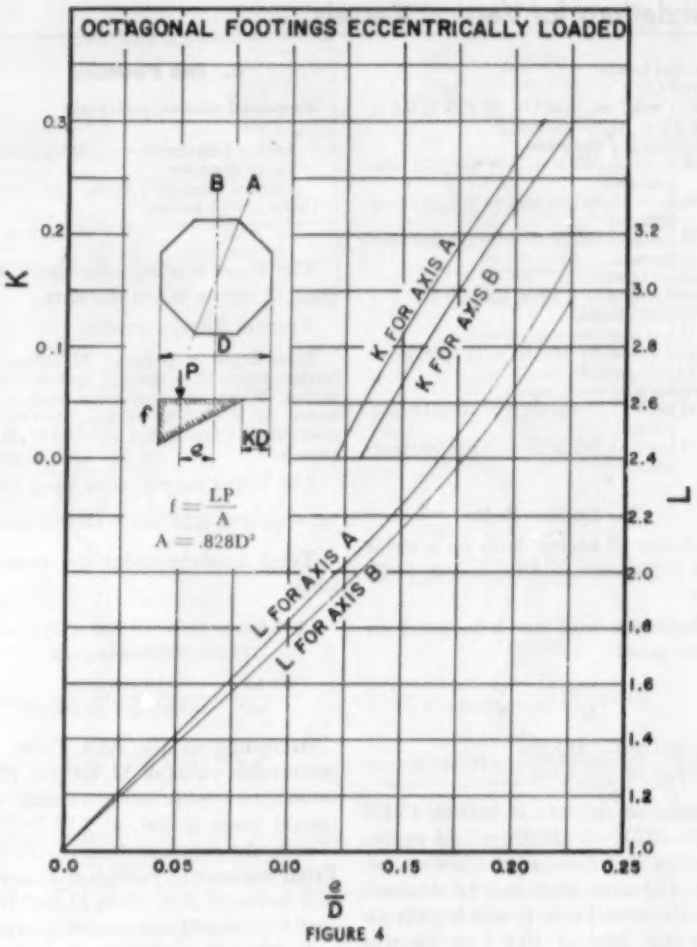


FIGURE 4

This may be figured in a similar manner (see the example following). It is well to remember that top reinforcement is objectionable in a base of this kind—in addition to requiring additional steel, it is hard to support, and adds to the difficulties of the workmen in handling chutes and placing concrete. If, therefore, the tensile stress in the concrete for this stress in the concrete for this case does not exceed that allowed by the code (3 percent of the ultimate strength of the concrete) it is recommended that top reinforcement be not used.

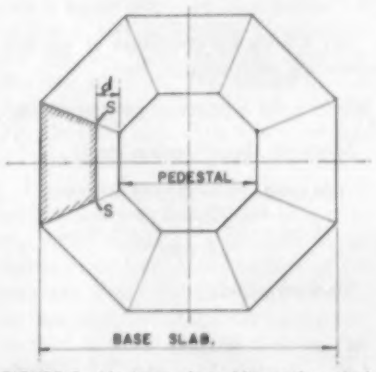


FIGURE 5—Maximum shear (diagonal tension) in base slab. Critical section "S-S" is located a distance "d" (net depth of base slab) from edge of pedestal. The total load taken in shear in length "S-S" is the total load on the hatched area.

6. Example

The example chosen is shown in Figure 6. The diameter of the vessel is 54 inches (60 inches with insulation). The height is 95 feet.

Specifications: ACI Code for design. Wind pressure, 30 pounds per square foot. Seismic coefficient, 10 percent. Allowable bearing pressure on soil, 4500 pounds per square foot, with or without lateral forces. Foundation to be of 2500-pound concrete. Normal steel stress, 20,000 psi. Normal stresses increased ⅓ for combination of vertical and lateral loads.

Vertical loads (V):
Vessel empty (a) = 101,200 pounds.
Vessel operating (a + b) = 117,400 pounds.
Vessel under test (a + c) = 191,900 pounds.

Lateral Loads:
Wind (d).
Total wind on vessel = $30 \times 5 \times 0.6 \times 1.2 \times 95 = 10{,}260$ pounds.
Overturning moments:
$H h_1 = 10{,}260 \times 47.5 = 487{,}359$ foot pounds
$H h_2 = 10{,}260 \times 52.0 = 533{,}520$ foot pounds
$H h_3 = 10{,}260 \times 54.0 = 554{,}040$ foot pounds
Seismic Load(e).
Vessel empty = $0.10 \times 101{,}200 = 10{,}120$ pounds
This is less than the wind load.
Vessel operating = $0.10 \times 117{,}400 = 11{,}740$ pounds
Overturning moments:
$H h_2 = 11{,}740 \times 51.5 = 604{,}610$ foot pounds
$H h_3 = 11{,}740 \times 53.5 = 628{,}090$ foot pounds

7. Anchor Bolts

Assume 16 anchor bolts on a circle with a diameter of 58½ inches (4.88 feet).

Maximum load per bolt, wind on empty vessel

$$T = \frac{4M}{DN} - \frac{V}{N} =$$

$$\frac{4 \times 487{,}350}{4.88 \times 16} - \frac{101{,}200}{16} = 18{,}700 \text{ pounds}$$

Required net area of bolt @ 15000 psi = 18700 ÷ 15000 = 1.25 sq. in. Use 1½ inch bolt, area 1.294 square inch. The same result may be obtained directly from Table 1, which gives an allowable load of 19.4 kips for this bolt. The lengths A_1, 12 inches, and B, 22 inches, and the size of the sleeve, 3 inches diameter by 18 inches long, may also be taken from Table 1.

Assuming the width of base ring to be 8 inches (this will be determined in the vessel design), the approximate maximum compression on the concrete may be obtained from formula (4), Art. 3. For this, the worst case occurs when the vessel is operating (V = 117,400 pounds), and D should be taken as the diameter of skirt, 54 inches. For consistency of dimensions, the moment is expressed in inch-pounds, 487,350 × 12 = 5,848,200 inch-pounds. Then

$$\left(\frac{117{,}400}{\pi \times 54} + \frac{4 \times 5{,}848{,}200}{\pi \times 54 \times 54}\right) \div 8$$

= 405 lb./in.²

Allowed by ACI Code for 2500 pounds concrete: 938 × 1.33 = 1250 psi.

Hence the bearing on the concrete is very small, and the approximate solution is adequate.

8. The Pedestal

Required size of pedestal:

Anchor bolt circle	58½ inches
Sleeve diameter	3
Vertical bars, say 2 @ ¾	1½
Cover, 2 @ 2 inches	4
	67 inches

The above is minimum. Use a pedestal 72 inches across the flats.

Vertical Reinforcement.

Total depth of pedestal, 72 inches. Effective depth 72 — say 2½ inches = 69½ inches. Width for equivalent rectangular beam, ⅝ × 72 = 45 inches. Weight of pedestal, 29.8 (area) × 4.5 × 150 = 20,100 pounds.

(1) Vessel empty, with wind load.

V = 101,200 + 20,100 = 121,300 pounds

Total moment about the tension steel:

533,520 × 12 + 121,300 × 33.5 = 10,466,000 inch pounds

$$\frac{M}{bd^2} = \frac{10{,}466{,}000}{45 \times 69\frac{1}{2} \times 69\frac{1}{2}} = 48$$

According to the ACI Code, the permissible value of M/bd^2 for 2500-pound concrete with vertical and lateral loads is 196 × 1.33 = 261. Hence, the concrete stress is very low. From commonly published charts, it will be found that, when M/bd^2 is 48, and f_s is 26,700, the concrete stress is only 540 psi, and the value of j is 0.935. Then the steel required is:

$$\frac{M}{f_s jd} = \frac{10{,}466{,}000}{26{,}700 \times .935 \times 69.5} = 6.05 \text{ sq. in.}$$

$$\text{Less } \frac{V}{f_s} = \frac{121{,}300}{26{,}700}$$

$$= 4.55$$

Net required = 1.50 sq. in.

(2) Check for condition of vessel operating with seismic load:

V = 117,400 + 20,100 = 137,500 pounds

Moment about tension steel:

604,610 × 12 + 137,500 × 33.5 = 11,862,000 inch pounds.
$M/bd^2 = 55$. $f_s = 570$ psi.
j = 0.93.

Steel required:

$$\frac{M}{f_s jd} = \frac{11{,}862{,}000}{26{,}700 \times .93 \times 69.5} = 6.85 \text{ sq. in.}$$

$$\text{Less } \frac{V}{f_s} = \frac{137{,}500}{26{,}700}$$

$$= 5.15$$

Net required = 1.70 sq. in.

For a pedestal of this size, it is advisable to use 16 vertical bars. Four may be considered effective as tensile steel. If No. 6 bars are used, four will give an area of 1.76 square inches, which is satisfactory.

It is seen that the above approximate calculation gives a reasonable area of required vertical steel. Where this calculation indicates an excessive amount of steel, more refined methods would be justified. It may be pointed out that the approximate method used is theoretically exact, except for the assumptions in par. (4) of Art. 4.

9. Base Slab

Diameter required. Try formula (5), Art. 5. M is maximum for the seismic condition, and has the value of 628,090 foot-pounds.

F_1 is 4500 lbs. per sq. ft. Then

$$D = 2.6 \sqrt[3]{\frac{628{,}090}{4500}} = 13.5 \text{ ft.}$$

Similarly, try formula (6), Art 5.

V = 191,900 pounds. $F_2 = 4500$.
$G = 2 \times 150 + 4.0 \times 100 = 700$. Then

$$D = 1.25 \sqrt{\frac{191{,}900}{3800}} = 8.9 \text{ ft.}$$

Assume D as 13 feet - 6 inches.

Check maximum base pressure.

Weight of vessel, operating	= 117,400 lbs.
Weight of pedestal	= 20,100
Weight of footing (assumed 2 feet - 0 inch thick) 151.0 (area) × 2 × 150	= 45,300
Weight of earth on footing (151.0 — 29.8) × 4 × 100	= 48,500
Total V	= 231,300 lbs.

Overturning moment (seismic = 628,090 foot pounds.
e = 628,090/231,300 = 2.71 ft.
e/D = 2.71/13.50 = 0.201

Entering Figure 4 with this value of e/D, for the diagonal axis, we find a value of L of 2.79.

Then the maximum base pressure is

$$F = \frac{LV}{A} = \frac{2.79 \times 231{,}300}{151.0}$$

= 4720 pounds per square foot.

Since the allowable value is 4500, the assumed size is satisfactory. The factor of safety against overturning is D/2e, or for this case, 13.50/5.42 = 2.5. Most codes require a minimum of 1.5 or 2.0. If the result is near the allowable minimum, a figure should be made for the condition of the empty

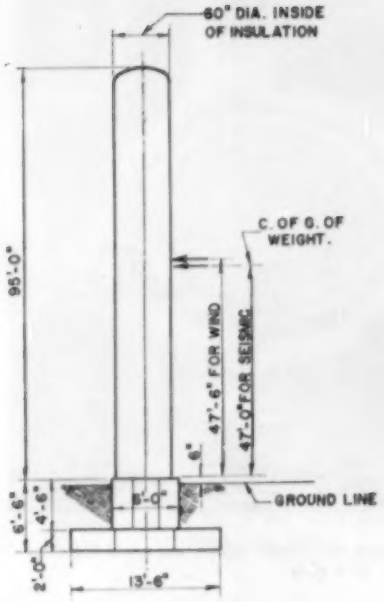


FIGURE 6

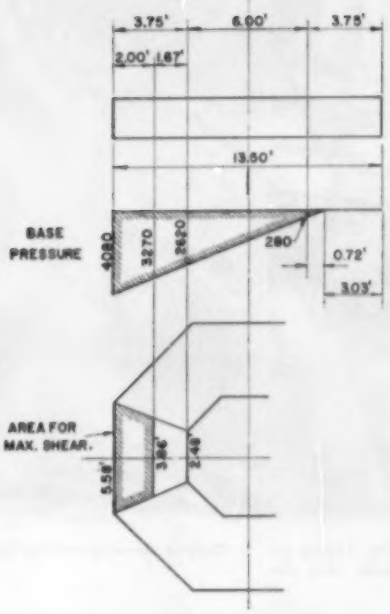


FIGURE 7

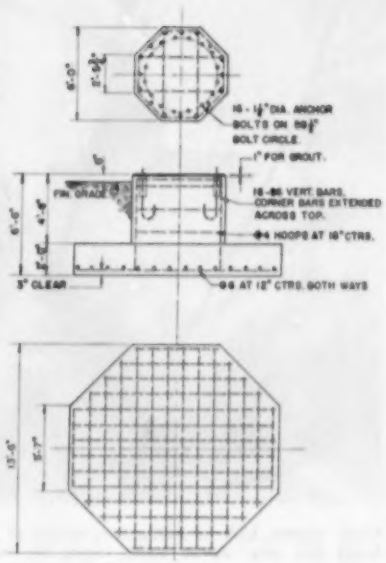

6'-0"
18 - 1" DIA. ANCHOR BOLTS ON 99" BOLT CIRCLE
1" FOR GROUT.
18 - #8 VERT. BARS, CORNER BARS EXTENDED ACROSS TOP.
#4 HOOPS AT 18" CTRS.
3" CLEAR
#6 AT 12" CTRS. BOTH WAYS
13'-6"

FIGURE 8

vessel plus wind load; this will probably give a slightly lower factor of safety.

For design, enter Figure 4 with the same value of e/D, and find for the axis parallel to the side of the octagon,

$$L = 2.66, \text{ and } K = 0.225.$$

Then the maximum base pressure is

$$\frac{2.66 \times 231{,}300}{151.0}$$

= 4080 pounds per square foot,
and $KD = 0.225 \times 13.50 = 3.03$ feet.

The diagram of base pressure is then drawn, as shown in Figure 7.

Moment per foot of width, about the edge of pedestal:

	Shear	Arm	Moment
2620×3.75	9825#	1.88'	18,240'#
$1460 \times \frac{1}{2} \times 3.75$	2740	2.50	6,850
Less footing and earth			
700×3.75	—2620	1.88	—4,950
Totals	9945#		20,320'#
For design, use 85% of these values:			
	8450#		17,270'#

The total thickness of base has been assumed as 24 inches. With 3 inches clear below the steel, and two layers of, say, 3/4 inch bars, the net depth is 24 - 3 - 3/4 - 3/8, or say 20 inches.

$$\text{Then } \frac{M}{bd^2} = \frac{17{,}270 \times 12}{12 \times 20 \times 20} = 43$$

With steel stress of 26,700, this will give a concrete stress of about 500 psi, and a value of 0.94 for j. Then

$$\text{Steel area required} = \frac{M}{f_s jd} =$$

$$\frac{17{,}270 \times 12}{26{,}700 \times .94 \times 20} = 0.41 \text{ sq. in.}$$

Try No. 6 bars @ 12-inch centers = 0.44 sq. in.

Unit bond stress

$$\frac{V}{\Sigma_o jd} = \frac{8450}{\pi \times .75 \times .94 \times 20} = 190 \text{ psi.}$$

Allowed by ACI Code, $200 \times 1.33 = 266$.

A simple rule to determine the maximum permissible size of bar, to be within the allowable bond stress, is this: For 2500 pound concrete, the diameter of bar should not exceed 1/50 of the toe projection, and for 3000-pound concrete it should not exceed 1/40 of the toe projection. This rule is exact when the base pressure is uniform, and sufficiently close where the pressure varies, as in the example. For the example, this would give a maximum bar diameter of $3.75 \times 12/50 = 0.90$ inch. The size used was 0.75 inch.

It remains to check the shear at the critical section, which, as shown in Figure 7, occurs at a distance of 20 inches (1.67 feet) from the face of the pedestal. From the data in Figure 7, we compute the total shear on the section, of a width of 3.86 feet, as follows:

$(4080 - 700) \times 5.58$	18,900
$(3270 - 700) \times 3.86$	9,900
	28,800

$28{,}800 \times \frac{1}{2} \times 2.08 = 29{,}950$ pounds.

$$\text{Unit shear} = \frac{\text{Total shear}}{bjd} =$$

$$\frac{29{,}950}{3.86 \times 12 \times .94 \times 20} = 35 \text{ psi.}$$

Allowed by code $75 \times 1.33 = 100$ psi.

It is seen that, as far as concrete stresses are concerned, the thickness of the slab could have been reduced somewhat. Such reduction, however, would save only a relatively small amount of concrete in the slab outside of the pedestal, and would have required an increase in the amount of steel. In this case, reduction of 3 inches in depth would save 1.1 cubic yards of concrete, and would require perhaps 100 pounds additional steel. The overall cost difference would be negligible. For this reason, it is common practice to use ample thicknesses for footings of this type.

The maximum moment for tension in the top of slab (windward side) may be figured as follows:

	$700 \times 3.75 = 2620\#$	1.88'	4925'#
Less	$280 \times .72 \times \frac{1}{2} = -100$	0.24	—25
	2520#		4925'#

Effective moment $4925 \times .85 = 4180'\#$

Unit stress on unreinforced concrete

$$\frac{6M}{bd^2} = \frac{6 \times 4190 \times 12}{12 \times 24 \times 24} = 44 \text{ psi.}$$

Allowed by Code $75 \times 1.33 = 100$ psi.

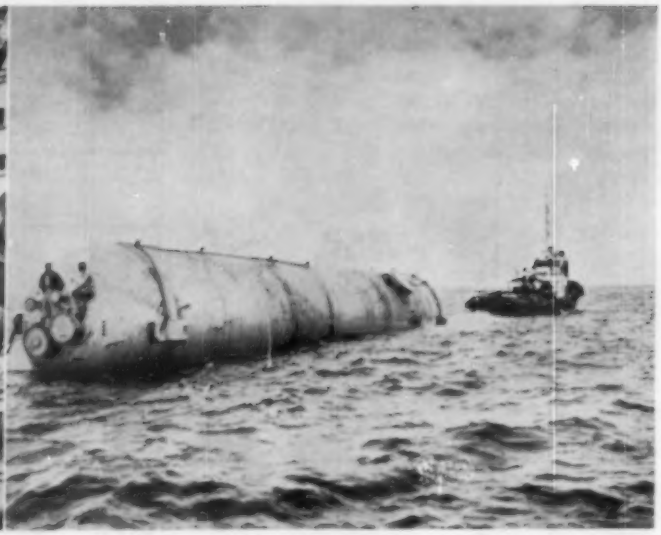
No top reinforcement is required.

The details of the complete foundation are shown in Figure 8. ##

LITERATURE CITED

[1] Gartner, A. L., "Nomograms for the Solution of Anchor Bolt Problems," Petroleum REFINER, Vol. 30, No. 7, July, 1951, p. 101.

Giant reactor, built in Amsterdam, arrives at Ras Tanura on board this ship. Jumbo boom lowers the reactor into the Persian Gulf.



Once in the water off Ras Tanura, the airtight column was towed 1½ miles to a pier.

Big Haul for Big Tube

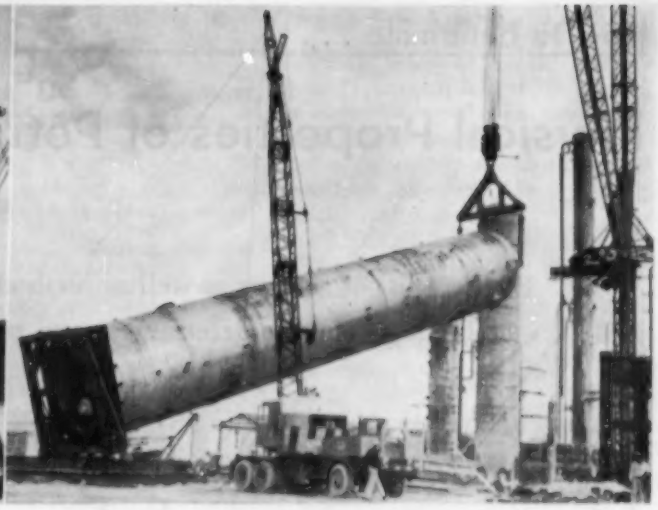
Near the pier, riggers bolted on wheels. It was then rolled over.

ARABIAN AMERICAN Oil Company recently completed a unique transportation feat in moving a giant reactor tube weighing 400,000 pounds from Holland to the Persian Gulf, floating it ashore and then towing it to the erection site at its Ras Tanura refinery.

One of the two ships in the world capable of lifting and handling such a tube, the German freighter, S. S. Braunfels, hauled the steel vessel from Amsterdam where it was built by Werskpoor. Designed to handle railroad locomotives, the S. S. Braunfels jumbo boom lowered the 200-ton reactor into the Persian Gulf waters without incident during the critical stage of the complex three and one-half-day ship-to-shore operation.

Construction and moving of the tube, planned for four years by engineers of Aramco in New York, London and The Hague and by Lummus, Ltd., London, also required three heavy duty tractor-trucks, a couple of

Two tractors pulled it out of the water and to the refinery seven miles away.



Guy derrick (right) erects the reactor based on steel rollers.

track-type tractors, a special set of four tires 10 feet in diameter (among the largest ever manufactured) and a crane 230 feet high. The tube stands 114 feet, three inches with an inside diameter of 16 feet, nine inches. It is the main reactor column of the new $12 million fluid hydroformer for the Saudi Arabian refinery scheduled to start producing high octane gasoline by July 1.

Once in the water off Ras Tanura, the airtight column was towed one and one-half miles by tugs to a pier. Couplings kept the tube from revolving in the water and two men rode it to shore. Near the pier, riggers bolted on two dollies that mounted the four 10-foot wheels. The vessel was then rolled over in the shallow waters to get the wheels underneath.

Two tractors pulled the column out of the water to a nearby road where a tractor truck, equipped with a fluid drive transmission which gave smooth starting and gear shifting, towed the vessel to the refinery seven miles away. At one point two additional large tractor trucks were needed to pull the giant column up a slight grade.

At the hydroformer site a guy derrick was erected on the plot to allow lifting of all the upright vessels. The derrick is atop a 50-foot tower guyed with four thick steel cables and the top of the guy mast is 230 feet above the ground held by 10 cables on a 600-foot radius. In raising the 200-ton column, the vessel's base was placed on steel rollers and the top was grasped by the derrick. The only incident in the entire operation was a failure by the crane's clutch due to the heavy strain just as the tube was nearing an upright position. After emergency repairs, the column was lifted almost 30 feet from the ground and swung into position atop a steel platform.

Construction on the Ras Tanura fluid hydroformer project commenced in May, 1954, and when on stream will charge 12,500 barrels daily of low octane naphthas turning out a high yield of high octane product. In addition to the large column built in Holland, other columns for the unit were constructed in France and other materials and supplies originated in Italy, England, Germany, Belgium, Canada, Ireland, Scotland and the United States.

Photos are courtesy of the Arabian American Oil Company. ##

After emergency repairs, the column was lifted almost 30 feet and swung into position atop a steel platform.

How to determine . . .

Physical Properties of Petroleum Fractions

Here's a list of sources as well as methods on using the characterization factor and average boiling points to determine many physical properties of complex mixtures.

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Austin

FOR THE NEOPHYTE engineer it is important to know or be able to predict physical and chemical properties of the materials with which he is concerned in analysis, processing, and application. In the case of mixtures of single compounds, it is feasible generally to use the basic physical and chemical properties of the single components, known or capable of laboratory determination, to predict properties of mixtures. This is the general practice even where properties of multicomponent mixtures of organic compounds need to be evaluated.

Petroleum oils and their fractions represent complex mixtures of hydrocarbon compounds, i.e., they are composed of a large number of hydrocarbon compounds some of which are not identified. Because these oils and fractions are of such a complex nature their properties represent mixture properties and not properties of compounds or pseudo compounds.

Adequate tests are available for determining the properties of oils but it is not always convenient or possible to use the tests.

Characterization of Oil Fractions

In the early 1930's Watson, Nelson, and co-workers[4,5,6] developed a means of characterizing petroleum oils and fractions which served as a correlating factor for many of the various properties. This relationship was named the *characterization factor* and has been called the UOP characterization factor or Watson K factor and defined as follows:

$$K = \frac{T^{1/3}}{S} \qquad (1)$$

Where K = UOP characterization factor
T = cubic average boiling point, °R.
S = specific gravity at 60 F.

This factor indicates the nature of the hydrocarbon compounds prevalent in the oil or oil fraction both as to the nature of the molecules and their molecular weights. A general range of K values for the different types of compounds are as follows:

Type	K
Paraffins	12 — 13
Cycloparaffins	11 — 12
Aromatics	9.5 — 10.5

The K value of a mixture can be computed from the K values of the petroleum fractions in the mixture as follows:

$$K_{mix} = K_1w_1 + K_2w_2 + K_3w_3 \ldots + K_nw_n \qquad (2)$$

Where K_{mix} = characterization factor of the fractions comprising the mixture

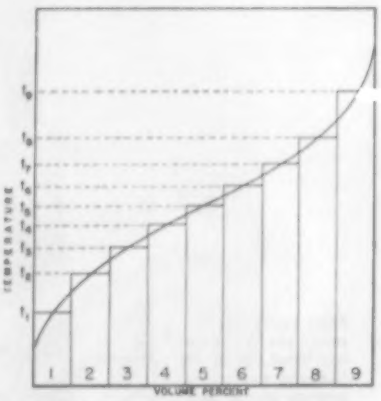

FIGURE 1—Volumetric average boiling point by integration.

and w_1, w_2, etc. = the weight fractions of the materials in the mixture.

Average Boiling Points

In order to correlate the various different properties of petroleum oils with reasonable accuracy, it was necessary to use a number of different definitions for average boiling points of the mixtures since the materials boiled over a range of temperatures and any one average boiling point failed to correlate all of the properties. The different average boiling points are defined as follows:

(1) **Volumetric Average Boiling Point**—The volumetric average boiling point is derived from the atmospheric ASTM distillation data. There are three methods in use for obtaining this boiling point.

(a) *Exact Method.* The exact method uses graphical integration of the differential ASTM distillation curve by taking suitable increments along the percent recovered axis (usually 10 percent increments) and determining the area under the curve. The area thus obtained is divided by the total percent included in the summation to obtain the mean temperature.

This method is shown in Figure 1. Mathematically the volumetric average boiling point can be expressed as

$$t_{(v)} = t_1v_1 + t_2v_2 + t_3v_3 + t_4v_4 \ldots + t_nv_n \qquad (3)$$

Where $t_{(v)}$ = volumetric average boiling point, F.
v_1, v_2, etc. = volume fraction of cuts 1, 2, 3, etc. having boiling points
t_1, t_2, etc. = F. (average boiling point of fraction 1, 2, etc.)

(b) *Approximate Method.* In the

approximate method the volumetric average boiling point is evaluated by adding together the boiling temperatures corresponding to the 10, 30, 50, 70, and 90 percent recovered from the ASTM distillation data and dividing the result by the number of temperatures used. Note: Use of the 10, 20, 30, 40, 50, 60, 70, 80, and 90 percent recovered temperature gives more accurate results. Thus mathematically:

$$t_{(v)} = \frac{t_{10\%} + t_{30\%} + t_{50\%} + t_{70\%} + t_{90\%}}{5} \quad (4)$$

(c) *ASTM 50 Percent Recovered Temperature.* If the ASTM distillation curve is symmetrical, and in many cases it is approximately so, the volumetric average boiling point may be considered as the ASTM 50 percent recovered temperature. Thus,

$t_{(v)}$ = ASTM 50 percent recovered temperature, F. (5)

(2) **Molal Average Boiling Point**—The Molal average boiling point of a petroleum oil or fraction may be defined as

$$t_M = x_1t_1 + x_2t_2 + x_3t_3 \ldots + x_nt_n \quad (6)$$

Where t_M = molal average boiling point, F.

x_1, x_2, etc. = the mole fractions of the narrow boiling cuts having boiling points at 760 mm of t_1, t_2, etc. F.

To determine these values it is necessary to select small narrow boiling cuts (so that a 760-mm boiling point can be assigned to each cut) evaluate the molecular weight of each cut and the molecular weight of the total mixture (to obtain the mole fraction represented by each cut.)

This is a laborious procedure and a chart (Figure 2)[2,3,4] correlating the molal average boiling point (and other average boiling points) with volumetric average boiling point and the 10-90 percent slope of the ASTM distillation curve was derived by Watson and co-workers. The slope is defined as follows:

$$\text{10-90\% Slope} = \frac{\text{90\% ASTM t} - \text{10\% ASTM t}}{80} = {}^\circ\text{/\%} \quad (7)$$

(3) **Cubic Average Boiling Point**—The cubic average boiling point is defined

$$t_{(CA)} = [v_1t_1^{1/3} + v_2t_2^{1/3} + \ldots + v_nt_n^{1/3}]^3 \quad (8)$$

Where $t_{(CA)}$ = cubic average boiling point F.

v_1, v_2, v_3, etc. = volume fractions represented by cuts 1, 2, 3, etc., having boiling points at 760 mm of t_1, t_2, t_3, etc., F.

The cubic average boiling point may be obtained from the chart referred to above (Figure 2).

(4) **Weight Average Boiling Point**—The weight average boiling point is represented as

$$t_w = w_1t_1 + w_2t_2 + w_3t_3 \ldots + w_nt_n \quad (9)$$

Where t_w = weight average boiling point, F.

w_1, w_2, etc. = weight fractions of narrow boiling cuts which have boiling points at 760 mm of t_1, t_2, etc. F. The weight average boiling point may be obtained from Figure 2.

(5) **Mean Average Boiling Point**—The mean average boiling point is the arithmetic mean average of the molal average boiling point and the cubic average boiling point. Thus,

$$t_{mean} = \frac{t_m + t_{CA}}{2} \quad (10)$$

The mean average boiling point may be obtained from Figure 2.

Properties of Petroleum Correlated by K and Average Boiling Points

Table 1 lists some of the properties of petroleum oils and petroleum oil mixtures correlated by characterization factor, average boiling point, and others.

API gravity can be determined as a function of many of the characteristics as shown above.

Some of the relations shown in Table 1 may be represented by equations.

Molal latent heat = $T_{(MA)}[7.58 + 4.57 \log T_{(MA)}]$

Wt. % $H_2 = 14.2 + 0.173$ API $- \frac{7250}{T_{(MA)}}$;

$T_{(MA)}$ = mean average boiling point, °R.

Wt % $H_2 = \frac{24.5}{S_m} - \left(\frac{19.4}{S_mK}\right)^3 - 8.6$

Where S_m = specific gravity at 60 F.

Meet the Author

M. VAN WINKLE, an old timer to most PETROLEUM REFINER readers, is author of two books, numerous book reviews and more than 40 articles of interest to the chemical and petroleum industries. The first of his articles appeared in the REFINER in 1943 and since then we have published at least a dozen. A graduate professor of chemical engineering at the University of Texas, Van Winkle received his B.S. degree at Purdue University and his M.S. at the University of Michigan, where he was an assistant professor when he joined the Texas faculty in 1947. He also taught in the School of Mineral Industries at Pennsylvania State College. Before taking up teaching as a profession, he acquired several years experience in research and development with Cities Service Oil & Refining Company and Standard Oil Company (Indiana) and served the University of Michigan as an industrial consultant.

TABLE 1

Properties of Petroleum Correlated by K and Average Boiling Points

PROPERTY	Correlating Factors	Reference
K	$t_{(CA)}$, API; t_{CA}, MW	(6), p. 1461
Molecular Weight	$t_{(MA)}$ API	(6), p. 1461
Critical Temperature	t_W, K; t_W, API	(1), p. 331; (6) p. 1461 (4), p. 1411
Critical Pressure	T_C, T_{PC}, P_{PC}	(4), p. 1413
Viscosity (Kinematic)		
210 F	API, $t_{(CA)}$; API, K	(6), p. 1461
122 F	API, $t_{(CA)}$; API, K	(1), p. 332; (6), p. 1461
100 F	API, $t_{(CA)}$; API, K	(6), p. 1462
Specific Heat (mean)		
Gases	t °F., K	(1), p. 335; (5), p. 884
Liquids	t °F., K, API	(1), p. 335; (5), p. 884
Heat of Vaporization	$t_{(MA)}$, API; $t_{(MA)}$, MW	(1), p. 337; (5), p. 885
Heat of Combustion		
Total	K, API	(1), p. 338;
H_2 Percent by Weight	$t_{(MA)}$, K	(1), p. 333; (6), p. 1463
Pseudo Critical Temperature	t_M, K; t_M, API	(1), p. 331 (4), p. 1411
Pseudo Critical Pressure	$t_{(MA)}$ API	(4), p. 1413

Examples in Use of Charts

(1) **Given:** Gasoline

ASTM Distillation

	°F.
Initial B.P.	92
10%	135
20%	180
30%	207
40%	227
50%	250
60%	274
70%	300
80%	326
90%	360
E.P.	398
API Gravity =	65.8

Determine: (a) K, (b) molecular weight,

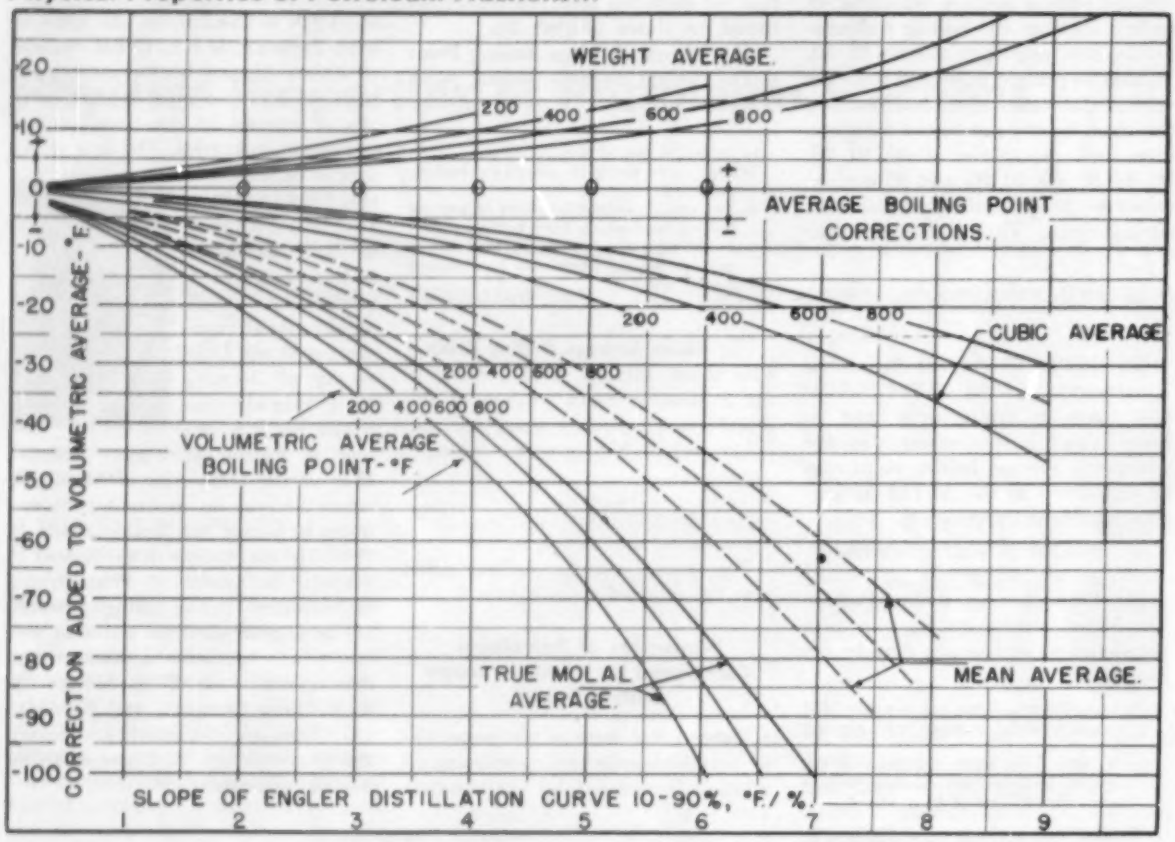

FIGURE 2—Relation of average boiling points.

(c) latent heat of vaporization, (d) percent hydrogen.

Solution:

(a) K

Volumetric average boiling point

	t F.
10%	135
30%	207
50%	250
70%	300
90%	360
	1252

$$t_v = \frac{1252}{5} = 250 \text{ F.}$$

$$\text{10-90\% Slope} = \frac{360-135}{80} = 2.8 \text{ °/percent}$$

To calculate the cubic average boiling point, on Figure 2 at an Engler slope of 2.8 F./percent, in the family of curves labeled "Cubic Average" at 250 F., read on the ordinate scale the correction—7 F.

$$t_{(CA)} = 250 - 7 = 243 \text{ F.}$$

K = 12.4 ($t_{(CA)}$ = 243°, API = 65.8)
(Ref. 6, p. 1461)

(b) Molecular weight

$t_{(MA)} = 250 - 18 = 232$ F. Figure 2

Molecular weight = 107 ($t_{(MA)}$ = 232, API — 6.58)
(Ref. 6, p. 1461)

(c) Latent heat

$t_{(MA)} = 232$ F. (API = 65.8)

Latent heat = 132 Btu/lb.
(Ref. 1, p. 337)

(d) Percent H_2

$t_{(MA)} = 232$ F., K = 12.4

% H_2 = 14.8
(Ref. 1, p. 333)

(2) **Given:** Light Lubricating Oil

ASTM Distillation (Atmospheric) Distillation run under 10 mm Hg pressure and curve transposed to atmospheric pressure by vapor chart.

	°F.
Initial B.P.	
10%	710
30%	790
50%	840
70%	920
90%	1030
API Gravity	28.5

Determine: (a) K, (b) molecular weight, (c) kinematic viscosity at 122 F., (d) critical temperature.

Solution:

(a) K

Volumetric average boiling point

	t F.
10%	710
30%	790
50%	840
70%	820
90%	1030
	4290

$$t_v = \frac{4290}{5} = 858 \text{ F.}$$

$$\text{10-90\% Slope} = \frac{1030-710}{80} = 4 \text{ °/percent}$$

$t_{(CA)} = 858 - 5 = 853$ F. Figure 2

K = 12.8 ($t_{(CA)}$ = 853°, API = 28.5)
(Ref. 1, p. 331)

(b) Molecular weight

$t_{(MA)} = 858 - 20 = 838$ F. Figure 2

Molecular weight = 235 ($t_{(MA)}$ = 838, API = 28.5)
(Ref. 1, p. 331)

(c) Kinematic viscosity at 122 F. = 65 centistokes ($t_{(CA)}$ = 853 F., API = 28.5)
(Ref. 1, p. 332)

(d) Critical temperature

$t_w = 858 + 5 = 863$ F. Figure 2

t_c = 1105 F. (t_w = 863 F., API = 28.5)
(Ref. 1, p. 331)

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Evaluating Economics by Nomograph

Evaluators need a fast, accurate and easily applied tool for rapidly estimating economics of new processes. Such a tool is the nomograph.

Robert D. Hill,
Celanese Corporation of America,
Clarkwood, Texas

PRELIMINARY ECONOMIC evaluations often become obsolete almost before the ink dries. This is bound to happen when raw material prices, product sales price, and estimated product sales volume fluctuate from day to day. The evaluator, therefore, needs a tool that will allow management to incorporate rapidly these changes into the estimate. The nomograph is such a tool. It also makes it possible to present the variables on one page. While several books on nomography are available, it is proposed here to bypass theory and show, step-by-step, the construction of a typical process economics nomograph.

The process taken for this example is the production of hydrogen cyanide from methane and ammonia. The basic data were taken from an article in the PETROLEUM REFINER.[2] This nomograph is designed to develop, as the final economic criterion, annual percent return on the total capital investment, including working capital. Ten percent of gross sales is deducted for sales, administration, and research costs,[1] and 52 percent of the profit is deducted for federal income taxes.

Author Robert D. Hill is now connected with Stanolind Oil & Gas Company, Tulsa.

About the Author

ROBERT D. HILL wrote this article after he became interested in nomographs and found their application particularly useful in his economic evaluation duties with Celanese Corporation of America. A chemical engineer, Hill has been with the company at Clarkwood, Texas, for the past three years. He is a graduate of the University of Oklahoma and received a master's degree in chemical engineering there in 1952.

He is a member of Pi Mu Epsilon, mathematics honor society.

TABLE 1
Production of Hydrogen Cyanide—Production Costs
(Basis: Production of 11,500 tons hydrogen cyanide per year.)

ITEM	$/Unit	Units/Day	$/Day	$/Lb. HCN
Raw Materials				
Ammonia	80.0/ton	26.8	2,144	
Natural Gas	0.15/M scf	1,764	265	
Catalyst and Chemical Makeup			126	
Total Raw Materials Cost			2,535	0.0402
Operating Expense				
Labor Charge				
Operators	2.25/hr.	48	108	
Supervision			54	
Labor Overhead and Supplies			49	
Total Labor Charges			211	0.0034
Utilites and Services				
Steam	0.20/M lb.	118	35	
Cooling Water	0.03/M gal.	3,530	106	
Electricity	0.007/kwh	8,820	62	
Total Utilities and Services			203	0.0032
Maintenance, 4% of investment per year			153	0.0024
Factory General, 35% of above operating expenses			187	0.0030
Royalty, 6.7% of paid-up fee per year			63	0.0010
Depreciation, 6.7% of total fixed capital per year			257	0.0041
Total Operating Expense			1,074	0.0171
Total Production Cost			3,609	0.0573

Economic Evaluation Nomograph

The Production of Hydrogen Cyanide from Ammonia and Natural Gas

1. Select the independent variables that the nomograph will present. In this example they are as follows:
   a. Cost of raw material ammonia.
   b. Cost of raw material natural gas.
   c. Plant size.
   d. Selling price of hydrogen cyanide.
2. Prepare a production cost table for the design rate. Raw material prices to be treated as variables in the nomograph are entered in the production cost table at their most probable values.
3. Prepare a table showing the total capital investment for the design production rate. Working capital is calculated with raw materials at their most probable prices.

TABLE 2
Production of Hydrogen Cyanide—Summary of Capital Investment
(Basis: Production of 11,500 tons of hydrogen cyanide per year. Marshal and Stevens Index—182.)

	Dollars
Total Fixed Capital	1,400,000
Working Capital:	
Raw Material Inventory*	76,000
Product Inventory†	108,000
Cash for Utilities, Wages, Supplies, etc.†	108,000
Accounts Receivable†	108,000
Total Working Capital	400,000
Total Capital Investment	1,800,000

* Calculated for 30 days at delivered cost.
† Calculated for 30 days at production cost.

4. Prepare a table showing the total fixed capital for each plant size that is to be presented in the nomograph. The total fixed capital is assumed here to follow the six-tenths rule.[3] If the

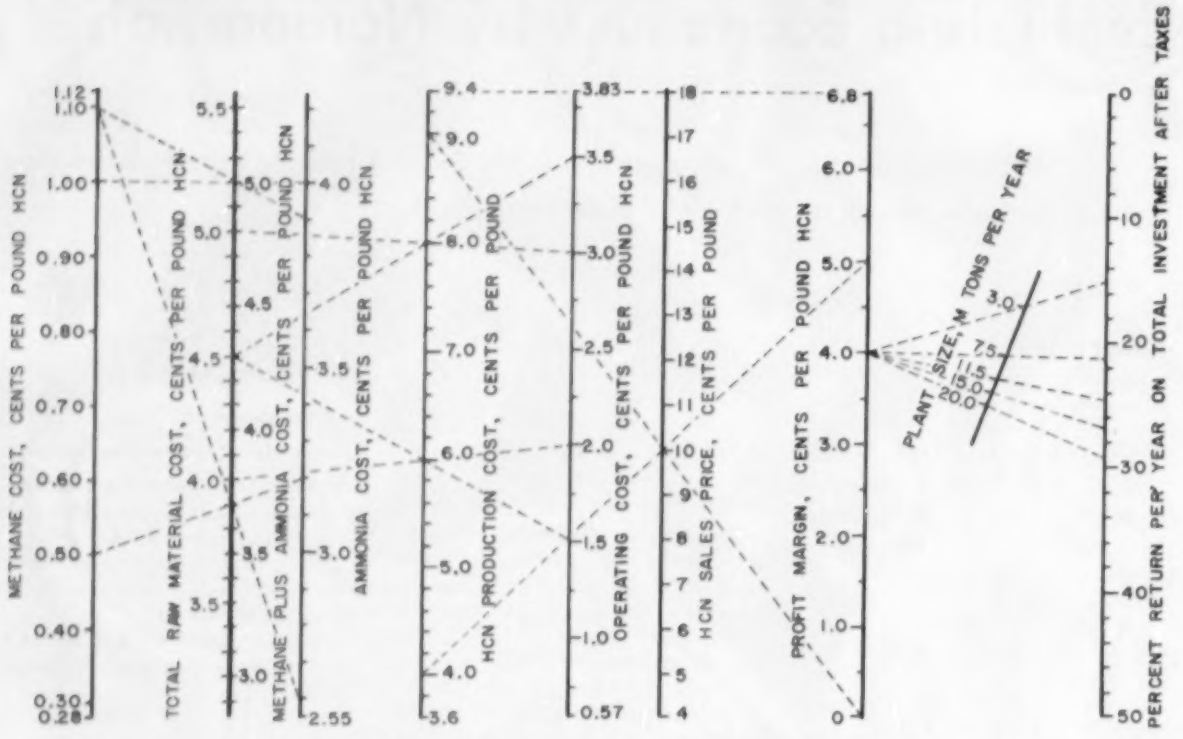
METHANE COST, CENTS PER POUND HCN
TOTAL RAW MATERIAL COST, CENTS PER POUND HCN
METHANE PLUS AMMONIA COST, CENTS PER POUND HCN
AMMONIA COST, CENTS PER POUND HCN
HCN PRODUCTION COST, CENTS PER POUND
OPERATING COST, CENTS PER POUND HCN
HCN SALES PRICE, CENTS PER POUND
PROFIT MARGIN, CENTS PER POUND HCN
PLANT SIZE, M TONS PER YEAR
3.0
7.5
11.5
15.0
20.0
PERCENT RETURN PER YEAR ON TOTAL INVESTMENT AFTER TAXES

FIGURE 1—Summary of economics of HCN production, showing nomograph construction steps.

production rates are very small, size exponents may not be applicable, and it may be necessary to estimate the plant cost independently for each flow rate.

TABLE 3
Total Fixed Capital

Plant Size, P, Tons/Yr. HCN	$\frac{P}{11,500}$	$\left(\frac{P}{11,500}\right)^{0.6}$	Total Fixed Capital ($P/11,500)^{0.6} \times$ $1,400,000
3,000	0.261	0.447	$ 625,000
7,500	0.652	0.773	1,080,000
11,500	1.00	1.00	1,400,000
15,000	1.30	1.17	1,640,000
20,000	1.74	1.39	1,950,000

5. Prepare a table showing the operating costs in dollars per day for each plant production rate. This table is most easily prepared by transferring directly the figures for the design rate from the production cost table (Table 1), and multiplying each item by the appropriate factor to obtain the corresponding figure for the other production rates. Utilities and services and royalty are assumed to be directly proportional to the production rate. Labor is assumed to be a constant for all production rates. Maintenance and depreciation are proportional to the 0.6 exponent providing the total fixed costs are proportional to the 0.6 exponent (see Step 4). If it is necessary to calculate the investment for each production rate separately, then it is necessary to calculate the maintenance and depreciation charges separately. Factory General is most easily calculated for each production rate independently. In this case it is taken as 33 percent of the other operating expenses exclusive of depreciation.

The totals of the above items are the operating expenses for the various production rates in dollars per day. Divide each total by the pounds of hydrogen cyanide produced per average day in the respective plants to obtain the operating cost in cents per pound of hydrogen cyanide.

6. Prepare a table showing the total capital investment necessary for each production rate. The total fixed capital is transferred from Table 3, and the working capital is calculated for each production rate as shown. The effect of changing raw material prices on working capital (and consequently,

TABLE 4
Production of Hydrogen Cyanide—Operating Costs

Plant Size, M tons/yr.	3.0	7.5	11.5	15.0	20.0
Total Labor Charges, $/day	211	211	211	211	211
Utilities and Services $/day	53	133	203	265	353
Maintenance, $/day	68	118	153	179	213
Factory General, $/day	110	153	187	216	256
Royalty, $/day	16	41	63	82	110
Depreciation, $/day	115	199	257	301	357
Total Operating Expense, $/day	573	855	1,074	1,254	1,500
Total Operating Expense, cents/lb. HCN	3.50	2.08	1.71	1.53	1.37

TABLE 5
Production of Hydrogen Cyanide—Total Capital Investments

	M Dollars				
Plant Size, M tons/yr.	3.0	7.5	11.5	15.0	20.0
Total Fixed Capital	625	1,080	1,400	1,640	1,950
Working Capital					
Raw Material Inventory*	20	50	76	99	132
Product Inventory†	37	76	108	136	177
Cash for Utilities, Wages, etc.†	37	76	108	136	177
Accounts Receivable†	37	76	108	136	177
Total Working Capital	131	278	400	507	663
Total Capital Investment	756	1,358	1,800	2,147	2,613

* Calculated for 30 days at delivered cost: $\left(\frac{P}{11.5}\right)$ ($76,000).

† Calculated for 30 days at production cost: $\left(\frac{P}{11.5}\right)$ ($76,000) ÷ 30 (operating expenses per day, Table 4).

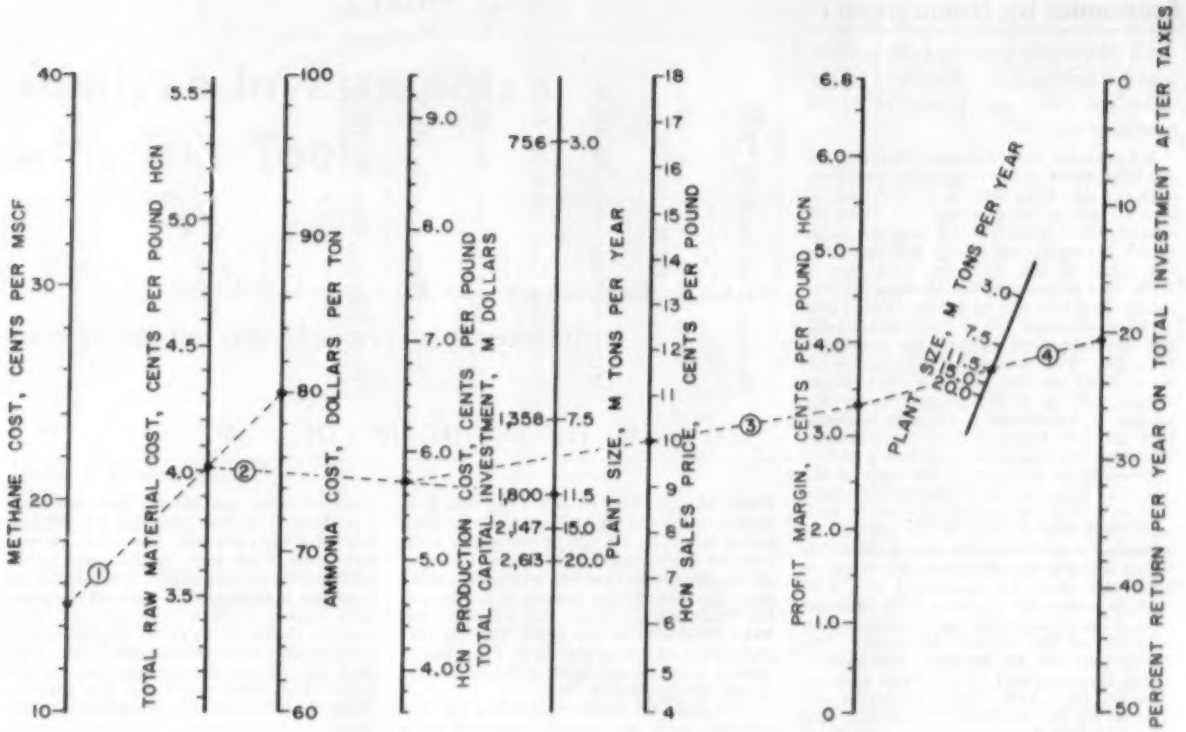
METHANE COST, CENTS PER MSCF
TOTAL RAW MATERIAL COST, CENTS PER POUND HCN
AMMONIA COST, DOLLARS PER TON
HCN PRODUCTION COST, CENTS PER POUND
TOTAL CAPITAL INVESTMENT, M DOLLARS
PLANT SIZE, M TONS PER YEAR
HCN SALES PRICE, CENTS PER POUND
PROFIT MARGIN, CENTS PER POUND HCN
PLANT SIZE, M TONS PER YEAR
PERCENT RETURN PER YEAR ON TOTAL INVESTMENT AFTER TAXES
1
2
3
4

FIGURE 2—Summary of economics of HCN production.

total investment) is ignored.

7. Prepare a table showing the desired ranges for the independent variables and showing the calculated ranges for the dependent variables (Table 6). The first eight items are also expressed in cents per pound of hydrogen cyanide, for this is the unit used in the construction of the nomograph. There is less chance of error if the nomograph is constructed on a common unit basis (Figure 1) and then completed in its final form by regraduating the scales with the desired units (Figure 2).

8. List the mathematical functions the nomograph is to perform. In this example the functions are:

a. Cost of Raw Material Ammonia + Cost of Raw Material Natural Gas + Cost of Catalyst and Chemical Makeup = Total Raw Material Cost.

b. Total Raw Material Cost + Operating Expense = Production Cost.

c. Net Selling Price — Production Cost = Profit Margin.

d. Profit Margin ÷ Total Capital Investment = Percent Return per Year.

9. Sketch a basic skeleton of the nomograph (final form in Figure 2). This skeleton (Chart A) which appears on the next page, shows the *approximate* positions of the scales and directions of increasing numbers on the scales.

The first step is (1) + (2) = (3), an addition function, so all lines increase upward. Note that the sum line is always in the middle. The next step is (3) + (4) = (5), another addition function, so again all lines increase upward. The third step, (6) — (5) = (7), can be rearranged to (7) + (5) = (6), which is also an addition step with (6) (sum line) in the middle; again these lines all increase upward. The last step, (7) ÷ (8) = (9), is rearranged to (7) = (8) × (9). For multiplication, two scales are vertical and linear, while the other must be a diagonal and non-linear. Also one of the vertical linear scales must increase upward and the other downward. Since (7) is already a vertical linear scale increasing upward, (8) or (9) must be the other vertical scale and increase down. It is more desirable to have the Percent Return (9) on a linear vertical scale to facilitate interpolation. Scale (8) is located on a diagonal connecting the zero points of scales (7) and (9). It is not linear and is graduated most easily by construction.

TABLE 6

Production of Hydrogen Cyanide—Ranges of Scales for Nomograph

ITEM	Indicated Extremities	Extremities, Cents/Lb. HCN	Range Cents/Lb. HCN
1. Raw Material, Natural Gas*	10–40 cents/M scf	0.28–1.12	0.84
2. Raw Material, Ammonia*	$60–100/ton	2.55–4.25	1.70
3. Methane + Ammonia Cost	2.83–5.57 cents/lb. HCN	2.83–5.57	2.54
4. Total Raw Materials (Ammonia + Natural Gas + Catalyst & Chemical Makeup)	3.03–5.57 cents/lb. HCN	3.03–5.57	2.54
5. Operating Expense	3,000–20,000 M tons/yr.	0.57–3.83	3.26
6. Production Cost	3.60–9.40 cents/lb. HCN	3.60–9.40	5.80
7. Profit Margin	0–6.8 cents/lb. HCN	0–6.8	6.80
8. HCN Selling Price*	4.0–16.0	3.6–16.2	12.60
9. Plant Size*	3,000–20,000 M tons/yr.		
10. Percent Return on Total Capital Investment after 52 Percent Income Taxes	0–50		

* Independent variables.

10. Physically construct the preliminary nomograph (Figure 1); the units are cents per pound of HCN produced.

a. Construct the Methane Cost line on the extreme left side of the page, and graduate the line from 0.28 to 1.12. A pair of dividers serves to graduate the lines accurately. Note from Table 6 that the range of the Methane Cost line is 0.84 and that the range of the Ammonia Cost line is 1.70. This means that the Methane + Ammonia Cost line will be located 1.70/(0.84 + 1.70) or about 2/3 of the distance from the Methane Cost line to the Ammonia Cost line. The location of sun line is always closer to the line with the larger range, and in direct proportion to the ranges. It is desirable to allow at least one half an inch between lines for lettering; therefore, the Ammonia Cost line is placed approximately 2 inches to the right of the Methane Cost line. Graduate this line from 2.55 to 4.25 in convenient increments, such as 0.10. Select a value of the methane + ammonia cost within the range shown in Table 6 and pick two cost combinations to equal this value. For example, 1.10 + 2.60 = 3.70, and 0.50 + 3.20 = 3.70. Intersection of lines connecting these points locates a point on the vertical Methane + Ammonia Cost line. Do the same with another value, for example, 1.10 + 3.90 = 5.00 and 1.00 + 4.00 = 5.00. The intersection will also be on the Methane + Ammonia Cost line. The line is then graduated linearly on the basis of the two known points (3.70 and 5.00). As a check the line should be vertical and have 2.83 and 5.37 as extremities. The cost of catalyst and chemical makeup is now added as a constant (0.20 cents per pound HCN) to the sum line to yield the Total Raw Materials Cost. This is done by adding 0.20 cents per pound to each number on the scale (see Figure 1).

b. The next step is the addition of the *total* raw materials cost to the operating cost to yield the production cost. From Table 6 it is noted that the range of the total raw materials cost is 2.54, and the range of the operating cost is 3.26. Therefore the Production Cost line will be located 3.26/(2.54 + 3.26) or somewhat over ⅔ of the distance from the Total Raw Materials Cost line to the Operating Cost line. By placing the Operating Cost line approximately 2½ inches to the right of the Total Raw Materials Cost line, the Production Cost line will be located approximately 1½ inches from the Total Raw Materials Cost line, approximately 1 inch to the right of the Ammonia Cost line, and approximately 1 inch to the left of the Operating Cost line. The Operating Cost line is scaled from 0.57 to 3.83, and the procedure used in step (a) is repeated to construct the Production Cost line.

c. Locate the Profit Margin line about 3 inches from the right-hand margin. This will leave room for the multiplication step (requires approximately 2 inches) and lettering, margin, etc. for the Percent Return line. The profit margin is to be added to the production cost to yield the HCN sales price. From Table 6 it is seen that the range of the production cost is 5.80 and the range of the profit margin is 6.80. This indicates that the HCN Sales Price line will be located a little over ⅓ of the distance from the Production Cost line to the Profit Margin line. In this case, this is a good location for the HCN Sales Price line, but occasionally the conditions will be such that the Sales Price line is located too close to the Operating Cost line when this procedure is followed. One remedy is to increase the Profit Margin range; this will move the Sales Price line to the right. This also increases the range of the Sales Price but is usually not serious as long as the new range is not inconveniently large.

The costs for sales, administration, and research costs are usually expressed as a percentage of the sales and are taken as 10 percent in this example. The HCN sales price is scaled in the same manner as in step (a), with the exception that 90 percent of the sum indicated on the scale is equal to the actual sum. This is most easily done by choosing the actual sum 9.0 (for example, 9.0 + 0 and 4.0 + 5.0) and marking the intersection on the HCN Sales line 10.0. This same procedure is followed to locate 18.0 (actually 9.4 + 6.8 = 16.2). The HCN Sales line is then graduated as usual on the basis of the two known points, 10.0 and 18.0.

d. Locate the Percent Return line about 2 inches to the right of the Profit Margin line and graduate it, increasing *downward* from 0 to 50. The maximum value of 50 percent is determined by taking the largest possible profit margin (6.8 cents per pound HCN) and calculating the return after 52 percent taxes using the largest plant size, as follows:

$$\text{Maximum Percent Return} = \frac{(\$0.068/\text{lb HCN})\ (0.48)\ 40{,}000{,}000\ \text{lb/yr HCN}}{\$2{,}613{,}000} = 50\%$$

Connect the zero points of the Profit Margin line and the Percent Return line. The connecting diagonal will be the Plant Size line. Mathematically it is a plant cost line, but it is graduated in terms of plant size, since this is the more important factor in using this portion of the nomograph. Graduate all points on the Plant Size scale by construction, since this scale is not linear. For example, the location of the 11.5 M tons HCN per year plant is found by the intersection of the diagonal and the line connecting 4.0 on the Profit Margin line and 24.6 on the Percent Return line. The percent return was calculated mathematically as above.

e. The nomograph just described is basically completed. All that needs to be done to present it in its final form (Figure 2) is to regraduate the scales to show the variables in their own units. The Methane Cost line is scaled from 10 to 40 and labeled in units of cents per M scf. The Ammonia Cost line is scaled from 60 to 100 and labeled dollars per ton. The total raw material cost is the same as that used in the preliminary nomograph. The Operating Cost line is graduated in terms of the plant sizes located by their respective operating costs as shown in Table 4. Corresponding total capital investments from Table 5 are then placed on the opposite side of the scale. The other scales are the same as those described in the preliminary nomograph.

f. Finally, check the completed nomograph by comparing its results with a mathematically determined one.

CHART A

Auiliary Nomographs

The nomograph just described is a basic type, useful in most economic studies. Frequently associated with this type of nomograph will be two other types which show quantities transferable to the basic nomograph:

1. A nomograph to show total raw materials cost as a function of varying prices of three or more raw materials. The result is transferred to the main nomograph as a Total Raw Material scale.

2. A nomograph to show total value of products as a function of individual selling prices of several concomitant products. A weighted mean selling price scale for the products is obtained in cents per pound total product, which is transferred to the main nomograph as Total Products Sales Price. This scale can be used just as the HCN Sales Price scale is used in the specimen nomograph.

ACKNOWLEDGMENT

The author wishes to express his gratitude to the Celanese Corporation of America for granting permission to publish this article.

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Analyze Investments with This Tool

Statistical approach offers a convenient means to evaluate the risk of a proposed investment.

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Husky Oil Company,
Cody, Wyo.

TAKE A LOOK at the investment analysis connected with a hypothetical plant to coke a heavy crude to produce coke, gasoline, and distillate. Table 1 shows the conventional analysis for one set of operating conditions. Both the payout and the percent return on the investment are attractive. Depending upon the company's policy, management is in a position either to take the risk or else to invest in another process that may have a better investment analysis.

Suppose that management has two such processes to consider from two competitive sources. Which one shall be picked? Here is where the engineer can offer direct guidance to management by analyzing the risk involved with the investment.

To study the statistical approach to the investment analysis of Table 1, a critical inspecion of one of the items in the table, the Direct Production Costs, is necessary (see Table 2).

In this case six items have been independently estimated n times. The number of independent estimates has varied from two to five, depending upon the item.

The column labeled $\bar{x}$ is the arithmetic average of the n independent estimates. The R column gives the maximum and minimum estimates. The value in the next column, labeled R/s is taken from Figure 1 which gives the average value of the ratio of the range of the estimates to the standard deviation of these estimates for the 95 percent probability limits. This curve was developed from mean values of R/s offered by Snedecor.[5]

The standard deviation, s, can then be determined by dividing the range by the constant from the curve. For instance, the standard deviation of the Raw Materials is determined by dividing the R/s value (1.69 at n=3) into the range

$$\frac{(\$2{,}414{,}000 - \$2{,}108{,}000)}{1.69} = \$189{,}900.$$

The other s values in the right hand column of Table 2 are determined similarly.

Direct Production Cost is the sum of the six items in the table. Its

TABLE 1
Conventional Payout Statement

ITEM		
Total Income from Sales		$6,700,000
Direct Production Costs	$2,466,500	
Indirect Production Costs	2,382,000	
Fixed Production Costs	494,000	
Manufacturing Cost of Sales		5,342,500
Gross Margin		$1,357,500
Fixed Capital	$4,345,000	
Working capital	850,000	
	$5,195,000	
Percent return on investment		26.3
Payout time, years		2.77

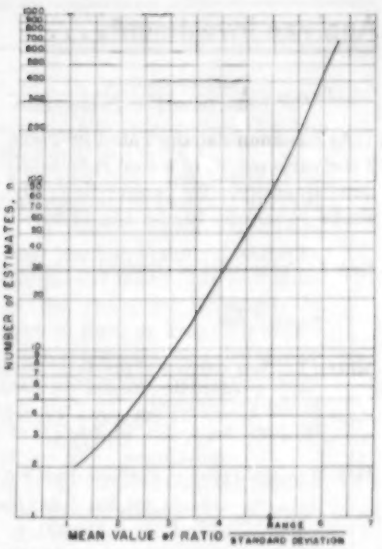

FIGURE 1—Number of estimates as a function of mean value of ratio.

standard deviation, however, is not the sum of the individual standard deviations. Instead, it is the square root of the sum of the squares of the individual standard deviations: s = $193,000. The square of the standard deviation is called the variance which is a valuable statistic because variances are additive whereas standard deviations are not.

The standard deviation for Indirect Production costs, Fixed Production costs, Working capital, Fixed capital, and Total Income from Sales are determined in the same manner.

In the case of Percent Return on the Investment and Payout Time, however, a different propagation of variance formula must be used because of the division operation which is inherent in the calculation of these quantities which are defined as follows:

$$\text{Percent Return on Investment} = \frac{\text{Net Income}}{\text{Total Investment}}$$

TABLE 2
Direct Production Costs

ITEM	n	$\bar{x}$	R	R/s	s
Raw Materials	3	$2,173,000	$2,108,000—2,414,000	1.69	$180,900
Labor	2	215,000	177,500— 252,500	1.13	66,300
Utilities	5	26,600	21,000— 30,000	2.33	3,860
Operating Supplies	2	6,100	5,500— 6,700	1.13	1,060
Maintenance	3	29,300	20,000— 36,000	1.69	9,480
Royalties	2	16,500	16,500	1.13	0
Direct Production Costs	..	$2,466,500			

$s^2 = (180{,}900)^2 + (66{,}300)^2 + (3{,}860)^2 + (1{,}060)^2 + (9{,}480)^2 + (0)^2$
$s = \$193{,}000$
n is the number of independent estimates.
$\bar{x}$ is the average of the individual independent estimates.
R is the range of estimates.
R/s is the mean value of the ratio of the range to the standard deviation.
s is the standard deviation of the item.

$$\text{Payout} = \frac{\text{Total Investment}}{\text{Net Income} + \text{Depreciation}}$$

As has been demonstrated in Table 2 the variance, s^2, of a sum is an additive quantity. By converting the above equations to the log form we can make use of this relationship. Conversion to logarithms to obtain the standard deviation of the quotient is as follows[6]:

For s_R standard deviation of Percent Return on the Investment:

Step I — conversion of standard deviation of Investment to logarithms.

$$s_{\log I} = \log \frac{(\bar{I} + s_I)}{(\bar{I})}$$

where: $\bar{I}$ = best estimate of the Total Investment
s_I = standard deviation of the Investment

$$s_{\log I} = \log \frac{(5{,}195{,}000 + 531{,}000)}{5{,}195{,}000} = .04224$$

Step II — conversion of standard deviation of Net Income to logarithms.

$$s_{\log N} = \log \frac{(1{,}357{,}500 + 552{,}000)}{(1{,}357{,}500)} = .14839$$

Step III — calculation of standard deviation of Percent Return on the Investment.

$$s^2_{\log R} = (.14224)^2 + (.14839)^2 = .02377$$
$$s_{\log R} = .1541$$
$$s_R = (1.426)\ (26.3) - (26.3) = 11.20$$

For payout time:

Step I — Net Income + Depreciation = 1,357,500 + 519,500 = 1,877,000
Standard deviation of Net Income + Depreciation

$$s_{(N+D)} = [(552{,}000)^2 + (53{,}100)^2]^{1/2} = 554{,}500$$

Step II — conversion of standard deviation of Net Income + Depreciation to logarithms

$$s_{\log (N+D)} = \log \frac{(1{,}877{,}000 + 554{,}500)}{(1{,}877{,}000)} = .11241$$

Step III — calculation of standard deviation of Payout Time.

$$s^2_{\log P} = (.11241)^2 + (.04224)^2 = .01441$$
$$s_{\log P} = .120$$
$$s_P = (1.319)\ (2.77) - (2.77) = .88$$

Meet the Author

FRANK B. ODASZ, who has been assistant director of technical services for Husky Oil Company since 1953, is interested in both light and heavy petroleum products and in refining problems. Formerly associated with Parmelee Motor Fuel Company in New York, he devoted his first six years with Husky to asphalt-products development. An interest in statistical methods lead him to the Institute of Statistics in 1951 and to Case Institute of Technology's operation research course in 1954. He received both his bachelor's and master's degrees in chemical engineering from the Polytechnic Institute of Brooklyn.

We now have the two best estimates of the two important decision factors and an index of their reliability. Table 3 summarizes the results.

These values may be used to develop a risk curve for the process, assuming a normal distribution.

Tables 4 and 5 illustrate the mathematical sequence used to develop the risk curves of Figures 2 and 3. The first step is to tabulate values of the statistic, $\frac{x_i - \bar{x}'}{\sigma}$, shown in the second column. This statistic corresponds to the percent of the total area under the normal distribution curve which is tabulated in the first column. By statistical inference we assume that the sample standard deviation, s, (0.88 year in the case of payout, for instance) estimates σ, the true standard deviation of the population.

Therefore: $x_i - \bar{x}' = \frac{(x_i - \bar{x}')s}{\sigma}$ so that @ 10% (−1.28) (.88) = −1.13. x_i in the last column is determined by recalling that $\bar{x}'$ is the mean estimate, 2.77 years. Thus $x_i = 2.77 - 1.13 = 1.64$ years.

This means that there are 10 chances in 100 that the payout time will not be more than 1.64 years. Naturally, a one-in-ten shot of making such a fast payout is not too appealing, but by means of Tables 4 and 5 the executive can select the risk he is willing to take and make his decision accordingly.

Figures 2 and 3 are risk curves which the engineer can present to the management as a guide to making the required decision. Two factors are evident from the curves.

1. By the shape of the curve and the range of value, it covers, management can decide whether the estimate itself is adequate for making a decision. It may be that too wide a range of values is covered and that more precision is desired. In such a case a statistical inspection of the in-

TABLE 3

Statistical Payout Statement

ITEM		$\bar{x}$	s
Total Income from Sales		$6,700,000	$480,000
Direct Production Costs	$2,466,500		195,000
Indirect Production Costs	2,383,000		191,000
Fixed Production Costs	494,000		24,000
Manufacturing Cost of Sales		5,342,500	275,000
Gross Margin		$1,357,500	552,000
Fixed Capital	4,345,000		
Working Capital	850,000		
Total Investment	5,195,000		531,000
Percent Return on Investment		26.3	11.20
Payout Time, Year		2.77	.88

TABLE 4

Probability That Payout Time Will Not Be More Than x_i Years.	$\frac{x_i - \bar{x}'}{\sigma}$	$x_i - \bar{x}'$	x_i (Yrs.)
10 chances in 100	−1.28	−1.13	1.64
20 chances in 100	−0.84	−0.74	2.03
30 chances in 100	−0.525	−0.46	2.34
40 chances in 100	−0.255	−0.22	2.55
50 chances in 100	0.00	0.00	2.77
60 chances in 100	0.255	0.22	2.99
70 chances in 100	0.525	0.46	3.23
80 chances in 100	0.84	0.74	3.51
90 chances in 100	1.28	1.13	3.90
95 changes in 100	1.65	1.45	4.22
99 chances in 100	2.33	2.05	4.82
99.9 chances in 100	3.09	2.72	5.49

TABLE 5

Probability That Percent Return on Investment Will Be At Least x_i Percent	$\frac{x_i - \bar{x}'}{\sigma}$	$x_i - \bar{x}'$	x_i (%)
10 chances in 100	1.28	14.3	40.6
20 chances in 100	0.84	9.4	35.7
30 chances in 100	0.525	5.9	32.2
40 chances in 100	0.255	2.9	29.2
50 chances in 100	0.00	0.0	26.3
60 chances in 100	−0.255	− 2.9	23.4
70 chances in 100	−0.525	− 5.9	20.4
80 chances in 100	−0.84	− 9.4	16.9
90 chances in 100	−1.28	−14.3	12.0
95 chances in 100	−1.65	−18.5	7.8
99 chances in 100	−2.33	26.1	0.2
99.9 chances in 100	−3.09	34.6	− 8.3

Behind This Method:

Petroleum people in general, and chemical engineers in particular, have been frequently called the world's best guessers. True enough, a competent engineer can evaluate data, merge it with experience and theory, and offer remarkably good estimates on designs, processes, and economic returns. The degree of correlation between his estimate and the actual result is directly proportional to the skill of the engineer.

Many articles[1, 2, 3, 9, 10] have been published describing modern statistical tools which have as their salient purpose the improvement of estimates, and a measure, called confidence or fiducial limits, of their reliability.

However, these articles are necessarily limited to just a few phases of the development of statistical methods and although extensive ingenious applications have been made, the greatest applications are still in the future.

The method described here is concerned with the management problem of evaluating the risk contingent with new investments. The principles behind this method were first outlined by Ferencz,[4, 5] who used his experience to develop a factor of 5.2 which he divided into the best estimate of the range of the values of the item of interest to obtain an estimate of the standard deviation of that item. Considerable protest was evoked from his readers because these basic assumptions of statistical theory were claimed to be violated:

1. Independent random samples of the population under study were not taken.

2. Theoretically, the divisor of the range is fixed by the number of independent random samples that were taken. The factor of 5.2, therefore, is valid only when approximately 100 independent random samples are taken as shown in Figure 1.

Most engineers will find that the problem of obtaining independent random estimates is perhaps the greatest obstacle to the successful application of the method. In the case of Ferencz's example, for instance, only one person made only one independent estimate of the range of estimates. In contrast, it is necessary to have at least two different people, or literature references, or price quotations, etc., or combinations so that either the range or standard deviation may be calculated. None of the estimates may be biased by the other and all must be estimates of the same population.

If this requirement is not fulfilled then the method degenerates to an intriguing hodgepodge of numbers. For instance, the method fails if an estimate is obtained by means of a question such as "I think the losses in this process will be about 0.5 percent. Do you think that's right?" There is a definite tendency for bias in such a question because it promotes an affirmative answer; this bias completely invalidates the method. Similarly, if the questioner above had one charge stock in mind and the answer offered his estimated based on another charge stock, the method would again be invalid because in actuality two different population means are being estimated.

The criterion of independent random samples from a common population is the foundation of statistical inference.

The problem of obtaining the necessary sample estimates can be resolved by posing unbiased questions to different engineers and specialists, by use of general correlations in the literature,[6, 7] and by obtaining estimates from consultants or suppliers.

vestment analysis table shows which items contribute most heavily to the high individual s values. The inspection may reveal that it is desirable to spend more money on market research to improve the estimates of the the total income from sales. Or, on the other hand, more expenditure may be justified in pilot plant work to improve the estimates of operating costs. Firm quotations may be solicited from equipment manufacturers to reduce the standard deviation of capital investment. The magnitude of the individual standard deviations indicates where additional expenditures are justified to improve the final estimates of investment return and payout.

2. Two alternative processes may be under study. The curves may cross as illustrated by the dotted line in Figure 3. Again the widest ranging curve may be improved through additional expenditures, or management may pick the process with the highest percent return on the investment at some given level of risk.

Basis for Action

In either case the curves are a basis for positive management action; either of three alternates can be selected: (1) abandon the process, (2) go ahead on the process, or, (3) make additional expenditure to improve the estimates.

As a synopsis to the above calculations the main items can be condensed in a useful nomograph as shown in Figure 4. For even greater flexibility certain of these scales such as manufacturing costs, income, or investment can be obtained from other nomographs as shown by Lynn & McKlveen.[19]

Note that in almost every discussion of an investment with management a question will come up, "Well, what would happen if so and so were different from your expected value?" The nomograph provides a means of quickly determining the payout and percent return for a wide variety of conditions, and furthermore, by connecting the estimated answer with the right-hand scale by means of a horizontal line the contingent risk can also be estimated. For example, the dotted lines illustrate the best estimates for the process, they show that for a Manufacturing Cost of $5,342.500 and a Sales

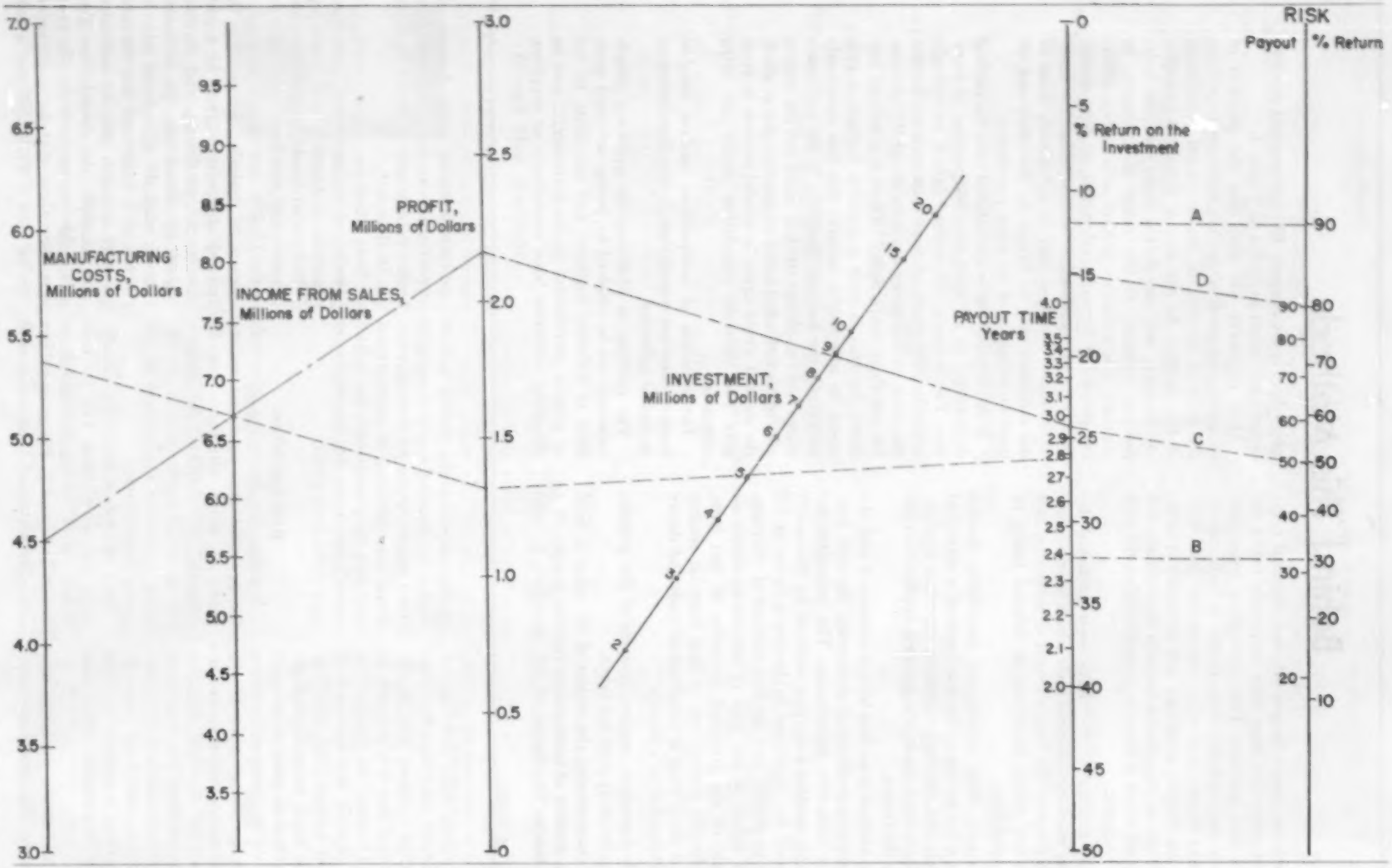

FIGURE 4—This nomograph is a good synopsis to the calculations.

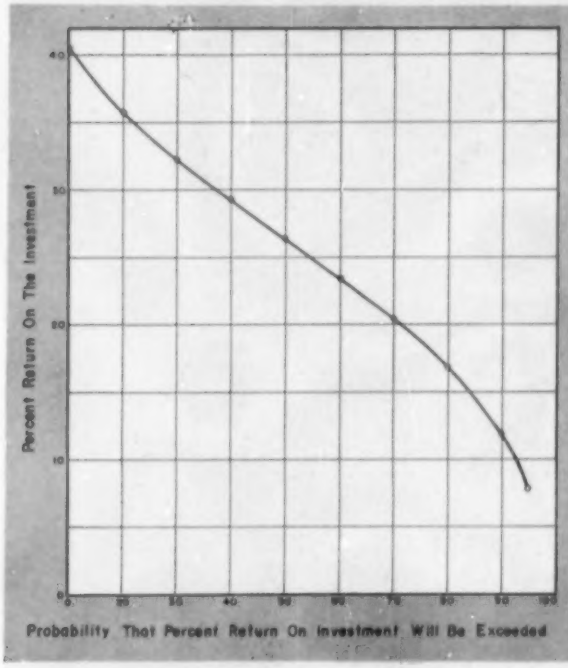

FIGURE 2—Risk curve for percent return on the investment: A guide for management.

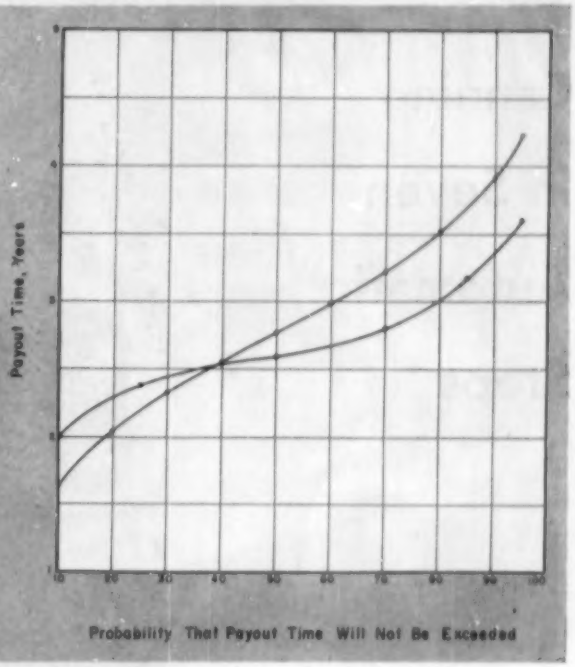

FIGURE 3—Risk curve for payout time: Another guide for management.

Income of $6,700,000, the Net Profit would be $1,357,500. If the total investment were $5,195,000 the Percent Return on the Investment would be 26.3 percent and the corresponding Payout Time would be 2.77 years. Moreover, the risks contingent with the expected values are 50 and 50, respectively, meaning that there are 50 chances in 100 that the Percent Return on the Investment will exceed 26.3 percent and that there are 50 chances in 100 that the Payout Time will exceed 2.77 years for the proposed investment.

Risks Analyzed

These risks are fairly self-evident. However, horizontal line A gives the additional information that there is a 90 percent chance of realizing better than 12 percent return. Horizontal line B shows the other extreme that there is only 30 percent chance of realizing better than 32.2 percent return.

Sometimes, the decision-maker would like to know what would happen if manufacturing cost were changed to, for instance, $4,500,000 and the investment changed to, say, $9,000,000. The nomograph gives 24.5 percent return on the investment and 2.9 years for the payout. The corresponding risks, however, can be obtained simply by shifting the risk scale upward so that 50 percent on the risk of the Percent Return on the Investment scale intersects the horizontal line from 24.5 percent Return on the Investment. Then for these new conditions the risks contingent with various returns and payouts can be estimated as before. For example, there are now 80 chances in 100 that the Percent Return on the Investment will be at least 15 percent. For convenience, the method of parallel lines can be substituted for the method of shifting the scales. First, a line connecting the new percent return with 50 percent on the Risk Curve is drawn, such as Line C. Then a Line D is drawn parallel to this line from any desired risk. In this case the risk is 80 percent. The intersection on the Percent Return Scale gives the same answer as the method of shifting the scales, i. e., 15 percent.

The technique of shifting the risk scale is valid only when the standard deviations of Mr. V. P.'s new conditions are the same as the original standard deviations. Otherwise, a new set of calculations must be developed.

Statistics is not a panacea for poorly planned experiments or carelessly obtained data. Statistical techniques will never improve data; they only improve estimates. Textbooks are helpful, but call in an expert when help is needed.[11, 12, 13, 14, 15, 16]

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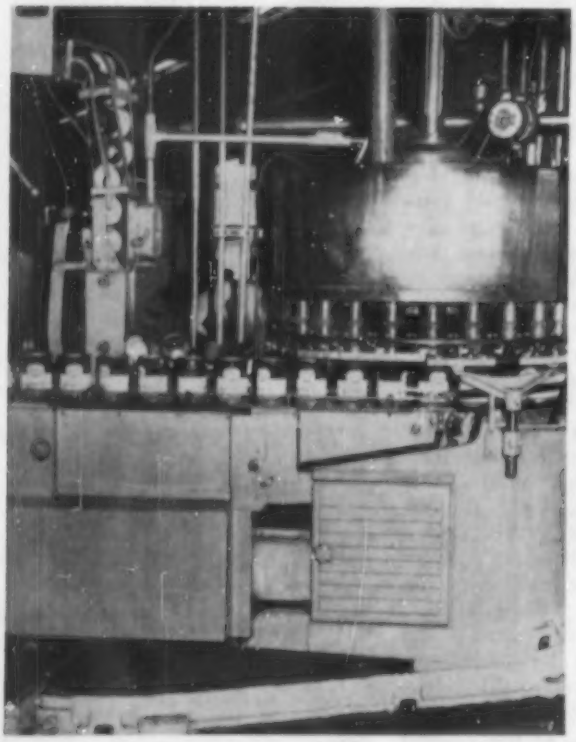
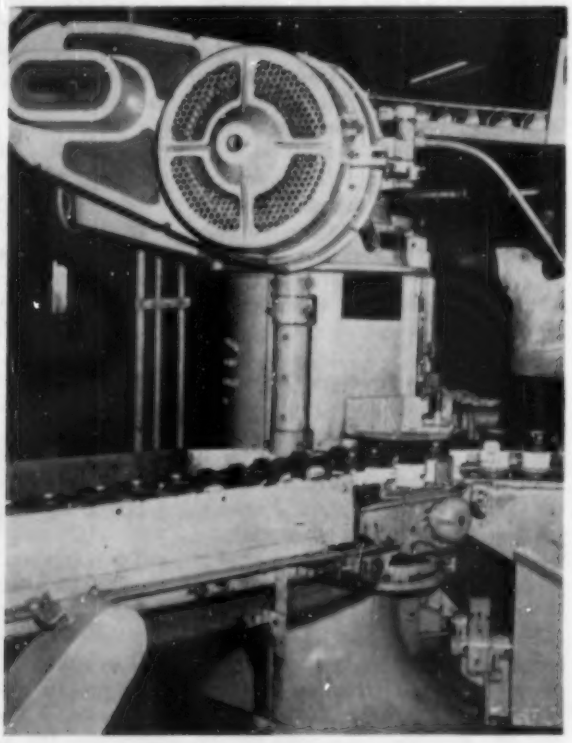
Canning In Seven Automatic Steps

1. The motor oil canning operation at Esso Standard Oil Company's Baton Rouge, La., plant starts at this incoming freight car where cans are unloaded on the first conveyor lap.

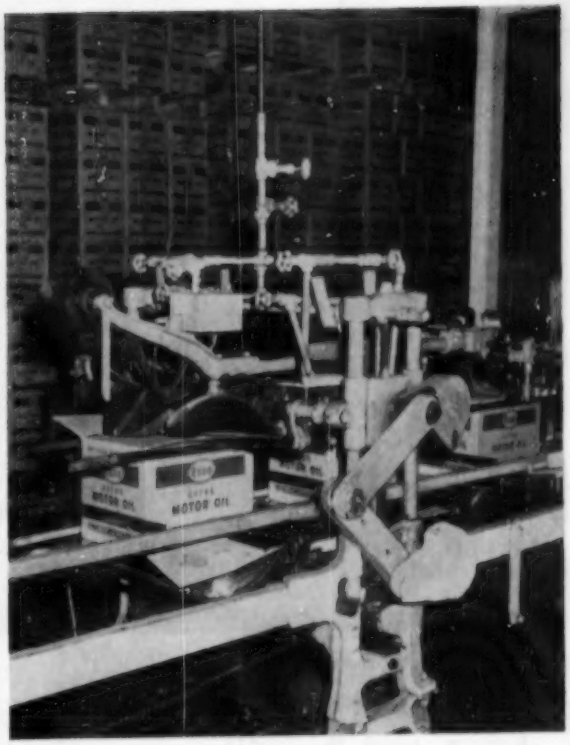


2. Cans are filled here with motor oil at the rate of 360 per minute.



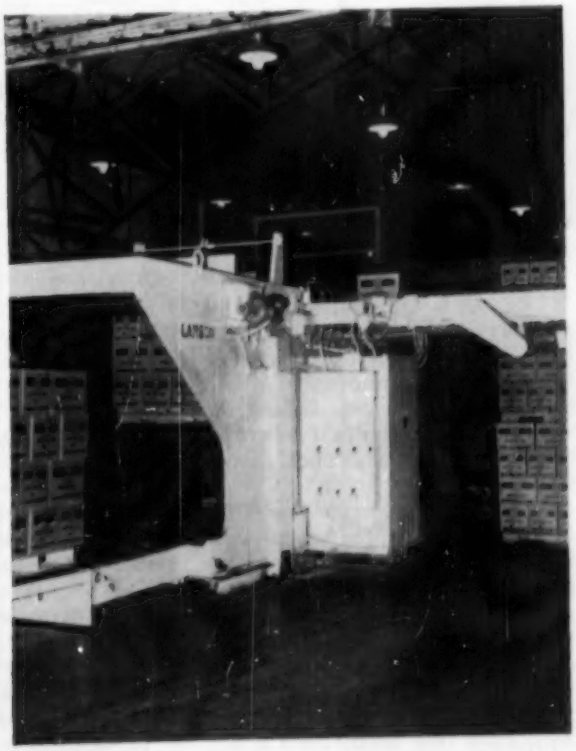
3. Filled cans move through the automatic sealing machine.

4. Cans are then packed in boxes of twenty-four each.



5. Mucilage is applied to boxes by box sealing machine.

6. Final step is this conveyor loading into an outgoing freight car.



7. Or they may be palletized for future pickup by a fork lift truck.

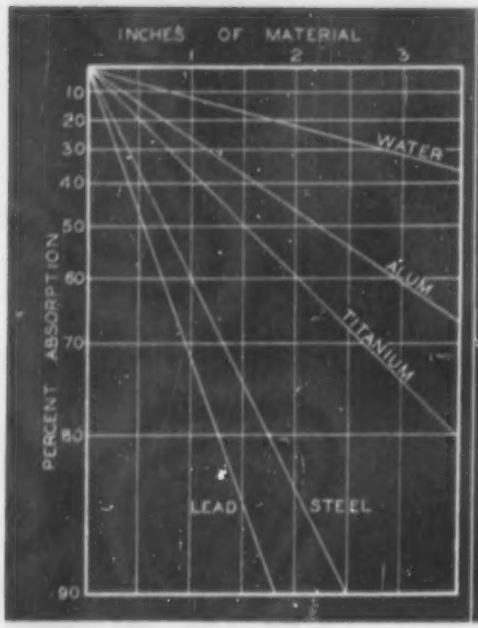


FIGURE 1. Gamma ray absorption.

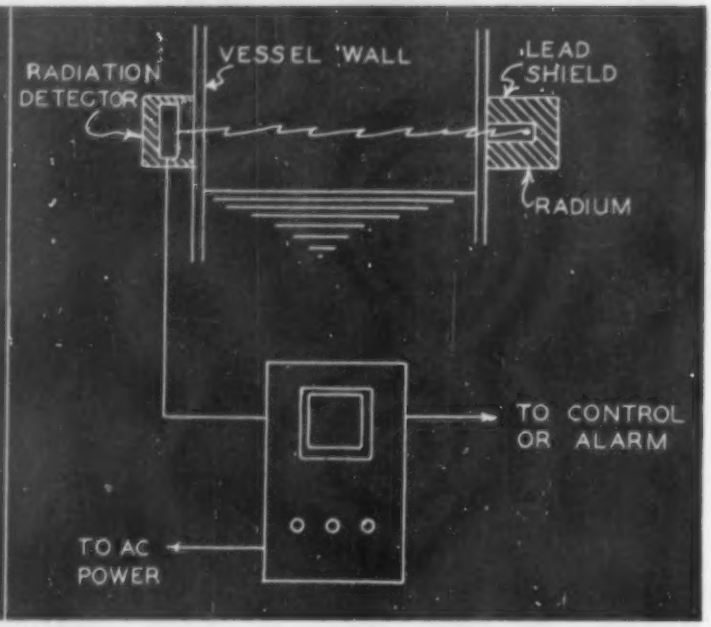


FIGURE 2. Point level control.

Radioactivity—New Tool for Refiners

Industrial radiation technology has advanced to the point that many applications have been particularly suited for refiners. Here is practical information on these uses.

W. B. Jarzembski,
Jacro Services, Inc., Tulsa

THE USE OF radioactivity for process control and measurement has paid off handsomely for the refining industry. So successful has this been that many refineries throughout the world now use measurements of radioactivity for many critical control applications.

The complete understanding of the underlying principles behind these radiation measurements is beyond our most astute physicists for it involves the very nature of matter. To understand the actual usage of radiation measurements, however, it is not difficult. For this understanding it is necessary to know what radiation does rather than what causes it.

Basically radioactivity is concerned with the generation, by matter, of radiation similar in many respects to light or heat rays. This radiation travels in straight lines and will be absorbed by the material through which is passes in much the same manner as light or heat. The major difference is in the amount of absorption by different materials.

There are several basic types of radiation but the type most commonly used for industrial applications is the gamma ray. This is because most of the process control uses of radiation depend on radiation absorption and gamma rays are the easiest to obtain and have ideal absorption characteristics for most applications.

The absorption of gamma radiation depends on the thickness of material through which it passes as well as the density of this material. For a close approximation if the material thickness is doubled the absorption is doubled and if the density is increased 10 percent the absorption will be increased 10 percent. Figure 1 shows the absorption of gamma radiation by various materials.

The first instruments to use gamma radiation for level control were developed in the research laboratories of a major oil company. These instruments were used for point level control as well as portable instruments for checking the accuracy of other level measuring devices. Figure 2 illustrates this class of radiation instruments.

A source of gamma radiation is placed on one side of the vessel and

a receiver of gamma radiation is placed on the other side of the vessel. The source of radiation is usually radium or radioactive cobalt and the detector of radiation is usually a Geiger-Muller tube. With the level of material completely below the path of radiation a certain amount of radiation will be received by the Geiger-Muller tube. As the level rises so that the entire radiation path is through the material in the vessel, the amount of radiation received by the Geiger-Muller tube will decrease in an amount that depends on the vessel diameter and the specific gravity of the material in the vessel.

The amount of decrease in received radiation for most vessels with a diameter in excess of 20 inches will be in the order of 90 percent. This is a great enough change to insure positive control action regardless of the aging of electronic components in the measuring and control circuits. For this reason the point level control or alarm instrument has proven to be extremely dependable and accurate.

There are many applications for an instrument that gives a control action when the level of material in a vessel reaches a certain point but in many instances it is necessary to know what the level is at all times. This has led to the development of two basic instrument types which give almost identical results. Both types use a source of gamma radiation such as radium and a detector of gamma radiation such as a Geiger-Muller tube arranged so that as the level rises the change in radiation absorption is proportional to the change in level. Figure 3 illustrates one type of instrument for measuring and indicating level by means of radiation absorption.

The instrument in Figure 3 uses a source of radiation as long as the level range to be covered and a Geiger-Muller tube with a sensitive length also equal to the level measurement range. The action of this instrument is similar to the operation of the point level control shown in Figure 2. As the level rises the amount of radiation received decreases because of the increased amount of material between the radiation source and the receiver. This change of radiation is indicated on a meter or recorder which is calibrated in terms of level.

Whereas the point level control depended on large changes in radiation for control action the continuous level indicator must depend on small changes and is dependent on the actual amount of radiation received being accurately measured and indicated. This calls for a more stable measuring system as well as very stable voltages from the electronic power supply. For this reason the level indicator is considerably more expensive than the point level control.

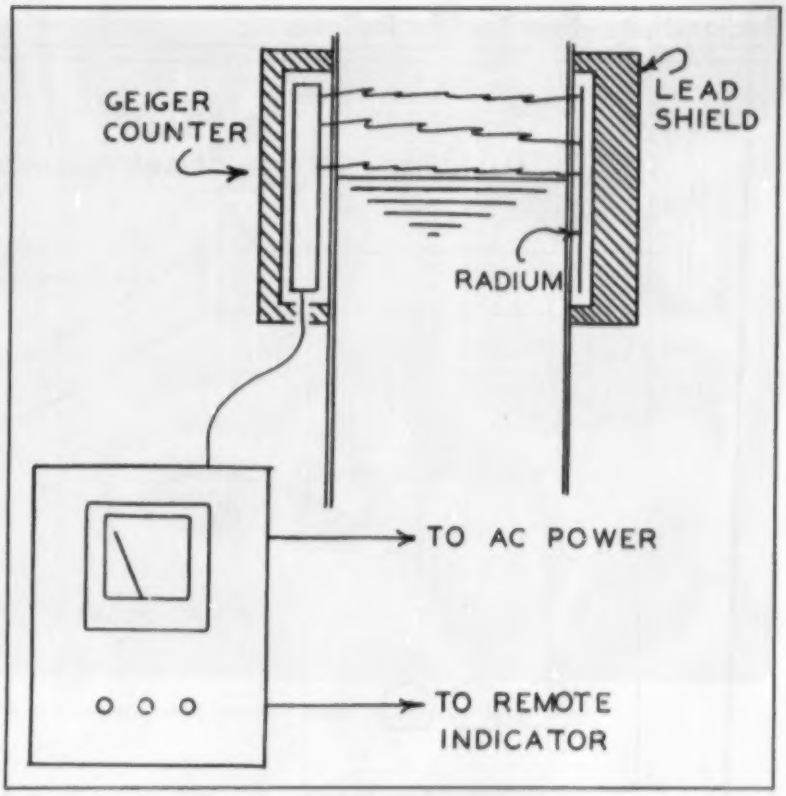


FIGURE 3. Level indicator.

Another important application of radiation in the refinery is in the measurement of material density. This method requires an installation similar to the point level control but with the accuracy and stability of the level indicator. The equipment is arranged so that the material under investigation always occupies a certain portion of the radiation path. As noted before the amount of radiation absorbed by a material is dependent on the density of the material. Thus, if the material always occupies a certain portion of the radiation path, any changes in material density will affect the radiation received and the amount of radiation received is an indication of the density of the material in the radiation path.

An important use of radioactivity in the refinery has not received the attention it deserves. This is the method of determining pipe wall thickness by radiation absorption as shown in Figure 4. Again a source of radiation and a radiation receiver are needed. They are arranged in a measuring head so that when the measuring head is placed against a pipe the path of radiation that is received by the detector passes tangentially through the pipe wall. As the wall thickness varies, the amount of radiation received varies. By passing the radiation through the pipe wall tangentially, a great increase in sensitivity is obtained over passing the radiation directly through the pipe wall. With this method the thickness of pipe may be determined by an experienced operator to within two or three percent.

This instrument is particularly valuable in inspecting boilers but is also very valuable for checking all of the piping in a refinery periodically to prevent a blowout due to corrosion. It is possible for an experienced operator to make measurements without removing the pipe from service in

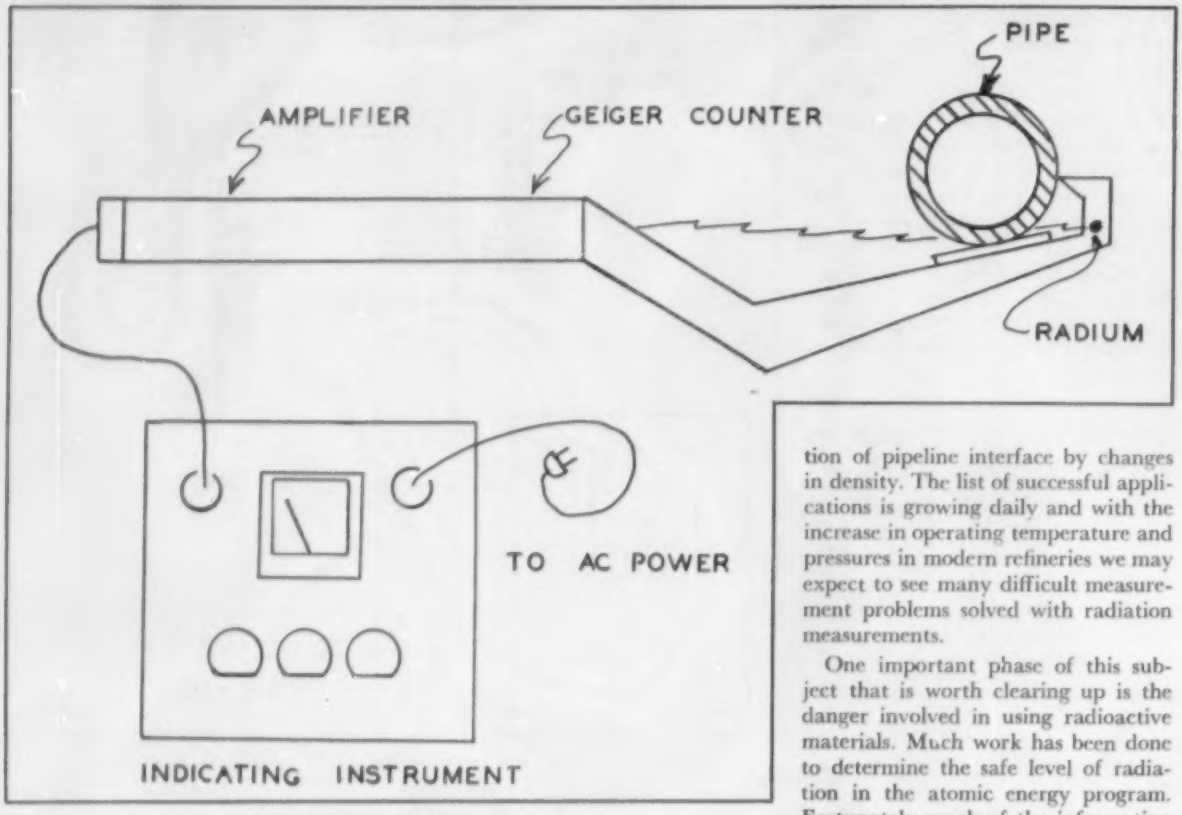


FIGURE 4. Pipe wall thickness meter.

many cases.

The author has made surveys with such an instrument where it was possible to detect corrosion inside the pipe as well as buildup inside of the same pipe but several feet away. Obviously it would not be possible with one measurement to detect both buildup and corrosion but it is often the case that where buildup occurs there is negligible corrosion.

The wall thickness indicator requires very accurate measurements of radiation. The indicator may be calibrated every day or, where measurements are critical, it may be calibrated after every reading. Therefore the instrument need not be as stable as the instrument for level measurement.

Radiation instruments are now in use in this country serving in applications where service conditions render other level measurement and control methods inoperable. The most prominent use of the radiation type level controller and indicator is for catalyst at temperatures above 1000 F. For this application there is no other way of satisfactorily measuring and controlling the level.

Other applications are for the detection of contaminants in a product by changes in density, and the detection of pipeline interface by changes in density. The list of successful applications is growing daily and with the increase in operating temperature and pressures in modern refineries we may expect to see many difficult measurement problems solved with radiation measurements.

One important phase of this subject that is worth clearing up is the danger involved in using radioactive materials. Much work has been done to determine the safe level of radiation in the atomic energy program. Fortunately much of the information obtained is directly applicable to industrial uses of radioactive materials.

The first rule of safety when dealing with radioactive materials is to consult a registered professional engineer in this field for recommendations as to the amount of shielding required for the amount of radioactive material recommended by the instrument manufacturer.

If the proper precautions are observed, there is no danger to the operating personnel or to the maintenance personnel. The author has handled amounts of radium far in excess of the amounts normally encountered in industrial process instrumentation without ill effects. Reference to Figure 1 will show that a few inches of lead will absorb a very high percentage of the radiation from any source. Due to the lack of absolute knowledge as to how much radiation is harmful the Atomic Energy Commission has set recommended levels of maximum radiation with a very liberal safety factor. The only danger in dealing with radioactive materials is the lack of caution brought on by familiarity. # #

Meet the Author

WILLIAM B. JARZEMBSKI, who has several years experience in designing and engineering process control instruments, wrote this article because he had become interested in the possibilities for using radioactivity in petroleum refining. Last year he organized his own firm, Jarcu Services, Inc., in Tulsa, to design and manufacture control instruments; he serves the company as its president. Jarzembski was graduated from Northwestern University with a degree in electrical engineering.

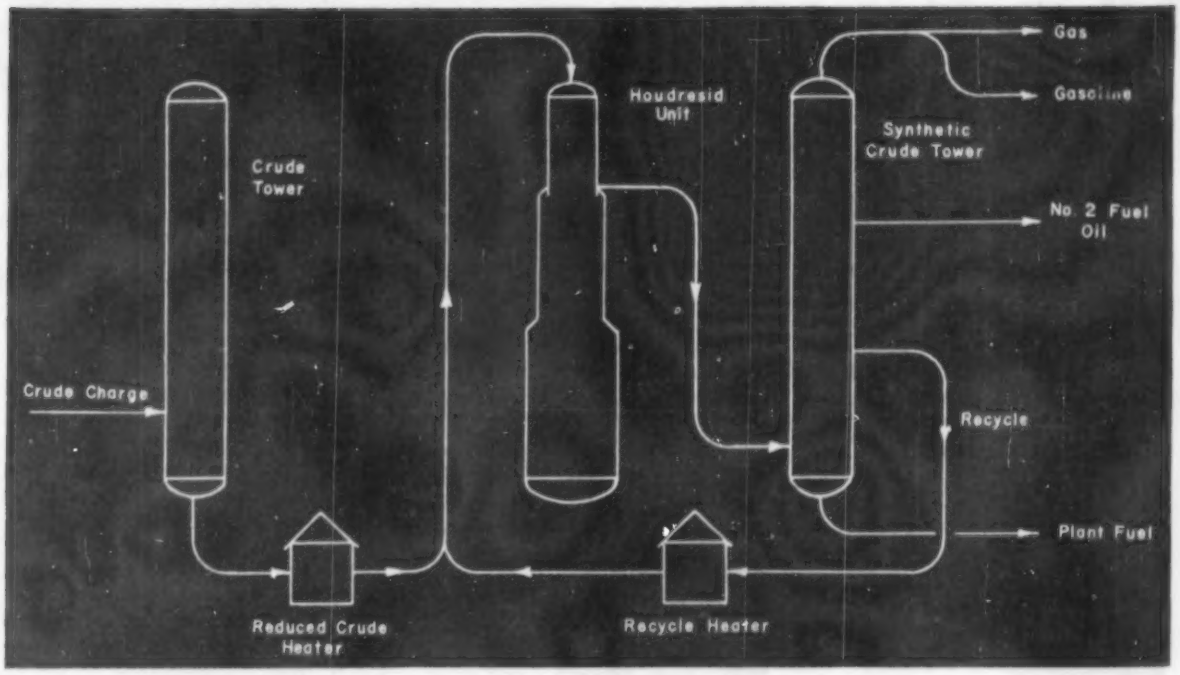


FIGURE 1—Flow diagram of Houdresid cracking operation: Similar equipment to Houdriflow.

Houdresid Process Cracks Residua

Using equipment similar to Houdriflow, heavy recycle gas oil is cracked to extinction.

J. C. Dart, G. A. Mills, A. G. Oblad and C. C. Peavy,
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DEMAND FOR gasoline and light distillate fuels has been increasing more rapidly in recent years than demand for heavy residual fuels, with the result that the disposal of heavy fuels on a profitable basis has been, in many places, a burden to the refiner. Considerable effort, therefore, has been devoted to the development of new refinery processing techniques that provide greater flexibility with respect to product demand as well as product quality.

Houdry Process Corporation has developed Houdresid catalytic cracking to meet these needs. Houdresid is a new refinery-proved, continuous moving bed catalytic cracking process for converting crude residua to high quality distillate products.

Houdresid cracking utilizes either natural or synthetic catalysts, and the equipment required is similar in many respects to that employed in Houdriflow catalytic cracking.

High yields of gasoline, with octane ratings typical of gas oil catalytic cracking, are produced from residuum cuts ranging from crude tower bottoms to vacuum bottoms. Process features eliminate the adverse effects on product selectivity heretofore resulting when heavy metals are present in the feed. In addition, residua high in sulfur or nitrogen may be charged.

Using a long range residuum, Houdresid has been in commercial operation for over a year.

Commercial Application of Process

Description of the Operation—The commercial demonstration was carried out at the Sarnia, Ontario, refinery of Sun Oil Company, Ltd. The operation began on March 14, 1954, and has been conducted with outstanding success since that time. A simplified flow diagram of the Houdresid process now in operation at Sarnia is presented in Figure 1.

The total crude is fractionated to produce gas, gasoline, naphtha, kerosine, No. 2 fuel with an ASTM 90 percent point no greater than 600 F.

and bottoms. Reduced crude from this distillation, representing about 45-50 percent of the crude, constitutes virgin feed to the Houdresid unit.

Synthetic crude from the Houdresid reactor is fractionated to produce gas, gasoline, No. 2 fuel, heavy gas oil, and a small bottoms cut which is consumed as refinery fuel. Heavy recycle gas oil is cracked to extinction.

The process and mechanical design of the Houdresid unit are based on information and equipment developed in the Houdriflow gas oil cracking process. Oil, catalyst, and air flows are similar to those in a Houdriflow unit previously described.[1, 2]

Process Results—Inspection of the reduced crude from mixed Louisiana, East Texas, and Mid-Continent crudes which is charged to the Sarnia Houdresid operation is presented in Table 1. Results of typical yield surveys are presented in Table 2.

Conversion ranged from 65 to 70 volume percent, variation being consistent with changes in throughput, recycle ratio, space rate, catalyst-to-oil ratio, and temperature during the residuum cracking operation.

The C_5^+ gasoline yields varied from about 48 to 53 volume percent, and coke yields varied from approximately 5.9 to 8.2 weight percent.

Considering changes in processing conditions, correlation of these data and data from other surveys indicates no significant shift in product distribution with time. Thus, the heavy metal contaminants which accumulated on the catalyst had no effect on the process results.

Unsaturation in the C_4 cut from the commercial operation has been consistently greater than 60 percent, and C_3 cut unsaturation has been more than 75 percent. These data are typical of Houdresid process results, and represent a substantial increase in unsaturation of these cuts over that obtained from gas oil catalytic cracking. Therefore, this process provides a greater potential polymer gasoline yield from polymerization of the C_3 and C_4 cuts.

The yields and octane ratings of the C_5^+ gasoline, without and with polymer gasoline and the latter blended to 10 pounds RVP, are presented in Table 3. The yields of 10-pound RVP gasolines (including calculated cat poly gasoline from polymerization of Houdresid C_3 and C_4 olefins) range from 63 to 66 volume percent of long range residuum and F-1 clear octanes range from 91 to 95.

Catalyst Resistance to Contamination—From March 14, 1954, to November 16, 1954, 802,000 barrels of residuum produced from 1,663,000 barrels of crude oil were charged to the Houdresid process at Sarnia. The history of metals accumulation on the catalyst and its effect on activity, as determined by the CAT-A laboratory test[3] during this period, are shown graphically in Figure 2.

The CAT-A activity of the natural catalyst was 26 prior to residuum

TABLE 1
Inspection of Charge to the Sarnia Houdresid Operation

CHARGE	Reduced Crude from Mixed Mid-Continent, Texas and Louisiana Crudes
Gravity, °API	26.9
Distillation, V.A., °F:	
Initial B. P.	650
50 Percent	804
E. P.	1066
Recovery, Percent	84.0
Sulfur, Wt. Percent	0.47
Ramsbottom Carbon, Wt. Percent	3.0
Nickel as Metal, ppm	4.6
Vanadium as Metal, ppm	6.1
Iron as Metal, ppm	9.4

Meet the Authors

JOHN C. DART, who is manager of research and development for Houdry Process Corporation, recently was elected director of the company. With Houdry since 1947, he previously was a chemical engineering instructor at Texas A & M College and had been associated with Pan American Refining Corporation, Magnolia Petroleum Company and Esso Laboratories. Holder of a B.S. degree from Albion College and a M.S. from the University of Michigan, he is author of several articles on catalytic processing and holds a number of patents in alkylation, hydrocarbon synthesis and catalytic cracking.

Dart

ALEX G. OBLAD, a chemist with a broad background in the petroleum industry, has worked chiefly in the fields of hydrocarbon catalysis, chemical thermodynamics of hydrocarbons and physical methods of analysis. In addition to experience with Houdry, his career includes research work with Standard Oil Company (Indiana), Magnolia Petroleum Company and Texas Research Foundation, which he served as head of its industrial research program. With Houdry since 1947 and holder of a doctor's degree from Purdue University, he has been granted a number of patents and is author of many articles dealing with the petroleum industry.

Oblad

CLAUD C. PEAVY, a vice president of Houdry and a previous contributor to PETROLEUM REFINER, has had many years experience in all phases of the refining industry. He joined Houdry as head of its Process Design division in 1946, a year later was moved up to chief engineer and in 1948, was made vice president in charge of engineering and sales. Previously, Dr. Peavy had been connected with Socony-Vacuum Oil Company five years as chief process engineer and had served E. B. Badger & Sons Company nine years as an engineer in the U. S. and other countries. He received his D.Sc. degree from the University of Michigan.

Peavy

G. A. MILLS, with Houdry since 1940, joined the company following a year as an instructor at Dartsmouth College, where he had gone after receiving his Ph.D. degree from Columbia University. At Columbia, he worked with H. C. Urey on the separation and application of isotopes. Except for war-time research in synthetic-rubber polymerization, Dr. Mills has been concerned with the development of cracking catalysts since he joined Houdry. His work has resulted in a number of patents on clay and other catalysts, and he is author of various articles on the acid chemical nature of cracking catalysts.

Mills

operation, and appears to have stabilized at 23.5. The gas and coke yields remained normal for these activity levels. Iron content of the catalyst increased from 1.0 to about 1.5 weight percent and has remained at this value.

Total nickel-plus-vanadium content of the catalyst was about 200 ppm before Houdresid operation commenced. This represents the approximate maximum tolerable limit of contamination in gas oil catalytic cracking.[4] Contamination above this limit in conventional catalytic cracking markedly influences cracking selectivity, so that high yields of light gases and coke, and low yields of gasoline, are the result of ordinary processing. By November 16, 1954, after eight months of Houdresid operation, the total nickel-plus-vanadium content of the catalyst had reached 870 ppm. It is extremely significant, therefore, that in Houdresid catalytic processing, these high concentrations of contaminants had no effect on product distribution or quality. In effect, the iron originally present in the natural catalyst along with the iron, nickel and vanadium deposited thereon during processing, had been rendered inactive.

Catalyst attrition on the Sarnia Houdresid unit averaged 2.5 tons per day (0.4-0.5# catalyst per barrel of reactor charge). The commercial experience has demonstrated that it is not necessary to withdraw catalyst, over and above that required from normal mechanical loss, in order to maintain selectivity and activity.

By March 21, 1955, more than a year after the new Houdry process was placed in commercial operation, approximately 1,127,000 barrels of reduced crude (produced from about 2,336,000 barrels of crude) had been processed in the Sarnia Houdresid unit. During this period, yields and product quality have remained high and unchanged.

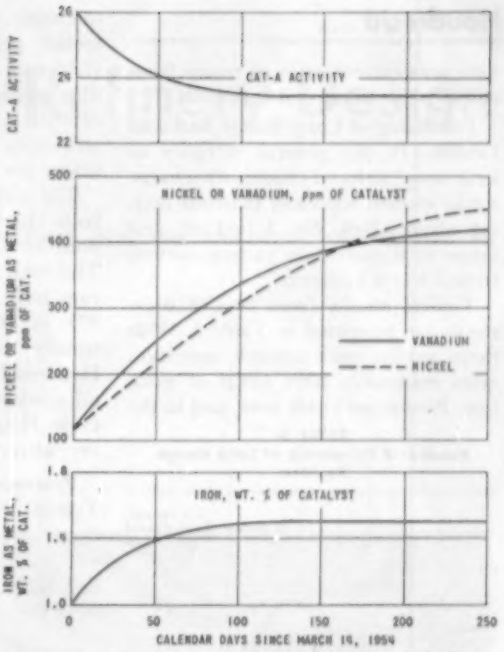

FIGURE 2 — Catalyst history: Not affected much by heavy metals in feed.

Laboratory Studies

Pilot plant studies have carried out to establish the various features of the Houdresid process, including a correlation of results of pilot plant and commercial operation.

It has been established thereby that both natural and synthetic catalysts may be used, and that an inexpensive natural catalyst is particularly well-suited to Houdresid.

A wide variety of long and short range residua, particularly those containing high concentrations of contaminants, has been evaluated. Typical results from these stocks, along with data comparing pilot plant and commercial operation, are presented in accompanying tables. The pilot plant used for these studies has been described previously in connection with the development of Houdriflow catalytic cracking.[5, 6, 7]

Commercial vs. Pilot Plant Results —Pilot unit and Sarnia Houdresid data from equivalent operation are presented in Table 4. The commercial data are from the survey of November 16, 1954, at which time 802,000 barrels of residuum had been processed. In general, the product distributions are in excellent agreement, and demonstrate that the pilot unit

TABLE 2
Sarnia Houdresid Survey Results

DATE	3-19-54	5-27-54	11-16-54	2-3-55
Crude, BPSD	10,180	12,360	12,111	12,800
Cracking Temperatures, °F	945	940	910	935
Houdresid Charge:				
Reduced Crude, bpsd	5,020	5,453	5,489	6,410
Recycle, bpsd	2,344	3,372	4,455	3,599
Total, bpsd	7,364	8,825	9,944	10,009
Yields (Based on Fresh Feed):				
Conversion, Vol. Percent	67.6	65.3	69.8	67.6
Debut. Gaso., 385 °F. at 90 Percent, Vol. Percent	48.5	50.1	52.7	51.6
No. 2 Fuel, Vol. Percent	25.4	22.1	30.2	23.0
No. 5 Fuel, Vol. Percent	7.0	12.6		9.4
C_4 Cut, Vol. Percent	14.8	12.4	12.9	13.1
Dry Gas, Wt. Percent	10.3	8.4	7.3	7.9
Coke, Wt. Percent	7.1	5.9	8.2	5.9
Cracking Efficiency: Vol. Percent Gasoline x 100 / Vol. Percent Conversion				
Hydrogen, SCF/Bbl. of Residuum Converted	129	147	108	138
Inspection of C_5+ Gasoline:				
Octane Number F-1 Clear	93.0	90.7	88.4	91.6
F-2 Clear	79.9	79.1	.....	79.1
RVP	6.0	5.1	.....	6.2
Sulfur, Wt. Percent	0.08	0.08	.....	0.08

TABLE 3
Houdresid C_5 + Gasoline Yields, Before and After Polymer Gasoline Blending

SURVEY DATE	3-19-54	5-27-54	11-16-54	2-3-55
Plant Data—Debutanized Gaso., Vol. Percent	48.5	50.1	52.7	51.6
F-1 Clear Octane	93.0	90.7	88.4	91.6
Calculated Debutanized Gaso. plus Polymer				
Gasoline, Vol. Percent	58.6	58.6	61.2	60.3
F-1 Clear Octane	94.7	92.5	90.3	93.2
Calculated Total 10 lb. RVP Gaso., Vol. Percent	62.8	63.4	65.9	64.3
F-1 Clear Octane	95.2	93.8	91.2	93.7

TABLE 4
Comparison of Houdresid Pilot Plant and Commercial Results

	Pilot Unit	Commercial Unit
Conversion, Vol. Percent	70.0	69.8
Debut. Gaso., 385 °F. at 90 Percent, Vol. Percent	50.5	52.7
Total Gas Oil, Vol. Percent	30.0	30.2
C_4 Cut, Vol. Percent	15.2	12.9
Dry Gas, Wt. Percent	9.6	7.3
Coke, Wt. Percent	7.9	8.2
Cracking Efficiency, Vol. Percent Gasoline x 100 / Vol. Percent Conversion	72.2	75.5

data are representative of results from commercial Houdresid operation.

Processing of Long Range Reduced Crudes—In the general category of long range reduced crudes, the charge stocks studied represent material boiling above virgin No. 2 fuel oil, and range in Ramsbottom carbon content from 2.8 to 4.5 percent.

Typical results from two of these stocks are presented in Table 5. With these stocks, once-through operation gives reasonably high yields of gasoline. Pilot plant yields here, and in the following tables, do not include potential polymer gasoline. The coke yields are slightly higher, naturally, than would be expected from a clean catalytic gas oil. However, the liquid recoveries from operation of these stocks are exceedingly high.

TABLE 5
Houdresid Processing of Long Range Residua

CHARGE STOCK	40 Percent East Texas Reduced Crude	27.5 Percent South-Central Texas Mixed Reduced Crude
Gravity, °API	23.7	22.7
Sulfur, Wt. Percent	0.54	0.52
Nitrogen, Wt. Percent	0.17	0.11
Ramsbottom Carbon Wt. Percent	4.5	2.8
Nickel as Metal, ppm	7.5	7.0
Vanadium as Metal, ppm	<2.5	5.0
Yields, Percent of Fresh Feed	**Once-Through**	**Once-Through**
Debut. Gaso., Vol. Percent	44.3	40.5
Cat. Gas Oil, Vol. Percent	39.7	44.1
C_4's, Vol. Percent	13.8	11.0
Dry Gas, Wt. Percent	7.9	9.5
Coke, Wt. Percent	6.9	6.2
Inspections of C_5+ Gasoline		
F-1 Clear Octane	91.6	94.1
Sulfur, Wt. Percent	0.06	0.11

The yield of C_4 is exceptional from both charge stocks, and the inspections of the gasolines are excellent. The total gas oils produced in these runs have end points in the range of 875 to 900 F. These gas oils are equally suitable for recycling in a Houdresid unit, or as charge to a gas oil cracking unit. As shown later, recycle Houdresid operation results in very attractive yields.

Processing of Heavy Residua—Typical results from Houdresid processing of tar separator and heavy vacuum bottoms are shown in Table 6, which presents data on 10.6 percent tar separator bottoms, a 10 percent vacuum bottoms and a 4.1 percent vacuum bottoms from several crude sources.

Processing the 10.6 percent bottoms from South-Central Texas mixed crude results in excellent gasoline yields, with reasonable coke production. The gasoline F-1 clear octane from processing this charge stock is 93.4.

TABLE 6
Houdresid Processing of Heavy Residua

CHARGE STOCK	10 Percent Mixed Mid-Continent, Texas and Louisiana Reduced Crude	10.6 Percent South-Central Texas Mixed Reduced Crude	4.1 Percent South-Central Texas Mixed Reduced Crude
Gravity, °API	12.6	17.7	12.7
Sulfur, Wt. Percent	0.91	0.72	1.02
Nitrogen, Wt. Percent		0.20	0.36
Ramsbottom Carbon, Wt. Percent	12.4	5.3	14.0
Nickel as Metal, ppm	18.8	16.2	47
Vanadium as Metal, ppm	7.4	13.0	33
Yields, Percent of Fresh Feed	**Once-Through**	**Once-Through**	**Once-Through**
Debut. Gaso., Vol. Percent	40.1	42.6	40.4
Cat. Gas Oil, Vol. Percent	40.2	37.0	27.1
C_4's, Vol. Percent	10.4	13.1	15.6
Dry Gas, Wt. Percent	7.3	11.6	13.5
Coke, Wt. Percent	10.3	8.5	17.6
Inspections of C_5+ Gasoline			
F-1 Clear Octane	89.3	93.4	90.7

With both the 10 percent mixed Mid-Continent, Texas and Louisiana vacuum bottoms and the 4.1 percent South-Central Texas mixed crude vacuum bottoms, good gasoline yields at octanes in the range of 90 are obtained. The coke yields are higher, as would be expected, than that resulting from conventional gas oil catalytic cracking. However, the Ramsbottom carbon content of these charge stocks is extremely high. With charge stocks of high Ramsbottom carbon content, no difficulty was encountered in operation of the unit.

Residua Containing High Metal Concentration—Residua having high sulfur, nitrogen, and metal content were investigated as potential Houdresid feed stocks. Typical pilot plant results obtained from four such stocks are given in Table 7. All of these stocks contain between 3 and 5 percent sulfur, and from 100 to 1100 ppm of heavy metals. The nitrogen contents range from 0.3 to 0.7 weight percent.

Once-through operation with these charge stocks results in debutanized gasoline yields of approximately 29 to 37 percent at conversion levels in the range of 50-65 percent. Coke yields vary from 15 to 22 weight percent.

Recycle operation, as shown for heavy Wyoming reduced crude, results in a substantial increase in gasoline yield, the increase amounting to 17 volume percent of charge, with only small increase in gas and coke yields.

Even with such highly contaminated charge stocks, gasoline octanes in the range of 90 to 92 F-1 clear are obtained. Both Ordonez and Boscan topped crude yielded approximately 2 weight percent hydrogen sulfide, which is included in the dry gas yield.

TABLE 7
Houdresid Processing of Residua Containing High Contaminant Concentrations

CHARGE STOCK	Ordonez Topped Crude	Boscan Topped Crude	Heavy Wyoming Reduced Crude		Kuwait Vac. Bottoms
Gravity, °API	12.3	7.7	12.2		9.7
Sulfur, Wt. Percent	3.72	4.96	3.48		5.03
Nitrogen, Wt. Percent	0.42	0.70	0.38		0.33
Ramsbottom Carbon, Wt. Percent	13.3	16.4	11.8		16.7
Nickel as Metal, ppm	61	74	37		42
Vanadium as Metal, ppm	242	1090	76		98
Yields, Percent of Fresh Feed	**Once-Through**	**Once-Through**	**Once-Through**	**Recycle**	**Once-Through**
Debut. Gaso., Vol. Percent	29.2	32.9	31.1	48.2	37.1
Cat. Gas Oil, Vol. Percent	49.6	43.8	44.5	26.1	34.6
C_4's, Vol. Percent	7.0	7.0	10.6	10.1	9.6
Dry Gas, Wt. Percent	9.8	8.8	10.4	12.3	9.7
Coke, Wt. Percent	15.1	18.6	15.2	18.2	22.1
Inspections of C_5+ Gasoline					
F-1 Clear Octane	90.3	92.1	91.8	93.0	88.9

ACKNOWLEDGMENT

The cooperation of Sun Oil Company in establishing the commercial feasibility of Houdresid in the Sarnia refinery is gratefully acknowledged, as are the contributions of its technical staff and management.

Acknowledgment is also made of Houdry personnel contributions made by J. W. Schall, D. H. Stevenson, J. B. Maerker, and F. Walser in pilot plant and commercial development, and by R. K. Smith, J. H. Krause, T. H. Milliken, and H. Heinemann in research leading to this new process.

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Relaxation Methods in Refinery Design

An explanation of the Relaxation Method and an example of its use in refinery design is presented.

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New York

MANY OF THE difficult engineering problems in refinery design can be solved without resorting to higher mathematics. Professor R. V. Southwell of England, and a group of collaborators have applied a method of computation called "Relaxation" to a great variety of problems in structures, mechanics and hydraulics.

In this article, the relaxation method will be used to find the deflection of a concrete beam of variable moment of inertia. This problem was chosen because it involves the basic principles of relaxation. It also has practical value in refinery design, because frequently the deflection of a support member must be obtained as a check against the flexibility of the mechanical equipment supported. Also, in planning supports for vibrating equipment the deflection of the supports is often used as a criterion for determining whether the support will vibrate.

Basic Theory

The deflection, w, of a beam, is a function of position, x, along the length of the beam and is related to the bending moment, M, by the equation

$$EI\frac{d^2w}{dx^2} = M_{(x)} \qquad (1)^1$$

TABLE 1—Properties and Residuals

Point	Simple Moment @ Point	h	I (Average)	$\frac{Mh^2}{I} = F^2$
1	144	4'	$\frac{(3.45)^3}{12} = 3.33$	$\frac{144 \times 16}{3.33} = 692$
2	256	4'	$\frac{(4.25)^3 + (1.25)^3}{12} = 0.718$	$\frac{256 \times 16}{.718} = 5,700$
3	336	4'	0.51	$\frac{336 \times 16}{.51} = 10,560$
4	384	4'	0.51	$\frac{384 \times 16}{.51} = 12,050$
5	400	4'	0.51	$\frac{400 \times 16}{.51} = 12,500$

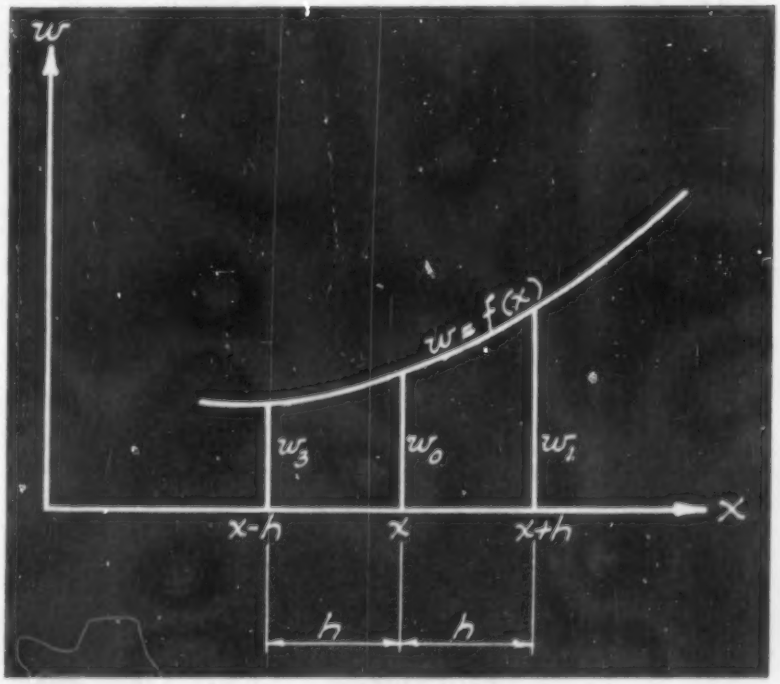

FIGURE 1—Deflected beam.

In order to solve for deflection, values of the wanted function, w, must be expressed at a number of equally spaced points of subdivision along the length of the beam. To do this, it is necessary to establish finite-difference approximations to the second order differential, (equation 1). The curve of Figure 1 represents a portion of the deflected beam.

Let f (x) be defined at the points x — h, x, and x + h on this curve. By

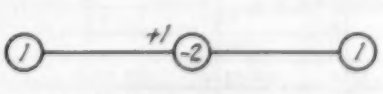

FIGURE 2a—Three-point relaxation pattern.

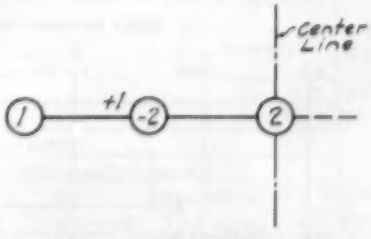

FIGURE 2b—Symmetrical relaxation pattern.

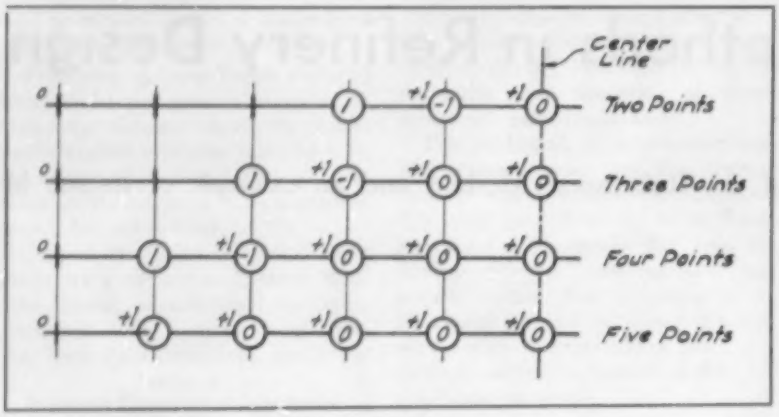

FIGURE 3—Block Operators.

expanding f (x + h) and f (x — h) into the Taylor series, there results

$$f(x+h) = f(x) + hf'(x) + \frac{h^2}{2!}f''(x) + \frac{h^3}{3!}f'''(x) + \frac{h^4}{4!}f''''(x) \quad (2)$$

$$f(x-h) = f(x) - hf'(x) + \frac{h^2}{2!}f''(x) - \frac{h^3}{3!}f'''(x) + \frac{h^4}{4!}f''''(x) \quad (3)$$

and, adding these, gives

$$f(x+h) + f(x-h) - 2f(x) = h^2 f''(x) + \frac{2h^4}{4!}f''''(x) + \quad (4)$$

Replacing $f^{(n)}(x)$ with $\frac{d^n w}{dx^n}$, w_0 for f (x), w_1 for f (x + h) and w_2 for f (x — h) the resulting expression is,

$$\frac{d^2 w}{dx^2} = \frac{w_1 - 2w_0 + w_2}{h^2} \quad (5)$$

in which terms of third power and above are neglected. Equation (5) is the finite difference expression for a second order differential. This equation, and finite difference approximations for first, third and fourth order differentials are generally available in standard reference texts.[2] Having divided the beam into n subdivisions it is possible to apply Expression (5) at each point of subdivision. It is unnecessary to write Expression (5) at the end points, sinc ethe deflection w, is known to be zero at the supports.

Substituting Equation (5) in (1) the expression

$$\frac{Mh^2}{EI} = w_1 - 2w_0 + w_2 \quad (6)$$

may be written at each point. Equation (6) is rewritten in residual form as follows:

$$F = w_1 - 2w_0 + w_2 - \frac{Mh^2}{EI} \quad (7)$$

where the symbol F, stands for the residual.

It is obvious that at any point along the beam the quantity $\frac{Mh^2}{EI}$ is readily calculable. Using n subdivisions will yield n — 1 simultaneous equations of the form (7). If values for w_0, w_1 and w_2 are introduced, it will be possible to solve for the residuals F_1, F_2 --- Fn — 1. In using the relaxation method, the computer ceases to look upon the problem as the finding of those values of w which satisfy Equation (7) but regards it as the determination of values for w which happen to make the residuals F_1, F_2 --- Fn — 1 zero. These values are automatically the wanted values.

The relaxation process, i.e. the process of liquidating the residuals, is set out in a convenient way. The procedure is to construct a *relaxation pattern* from Equation (7), by means of which the residual at each subdivision is calculated. It is obvious that at any point, the residual has its value changed by —2 if a unit increment is added to the value of w at that point, and has its value changed by 1, if a unit increment is added to the value w at either neighboring point of the subdivision. Thus, the complete effect of an increment applied to the value of w_0 at a typical point is to change the residual at that point by —2 and to change the residuals at the two neighboring points each by 1. This effect is illustrated in Figure 2a in the form of a relaxation pattern. The changes to the residuals are recorded in circles in the same relative positions as would be occupied by any set of three typical points of subdivision actually marked out along the beam, the unit increment (+1) is recorded in Figure 2a in a position near to the typical point where it is applied. This relaxation pattern represents a basic unit operation for use in solution of Equation (7).

TABLE 3—Relaxation Diagram

	POINT 1		2		3		4		5 (E)	
W	F	W	F	W	F	W	F	W	F	
0	0	0	692	0	5700	0	10550	0	12050	0	2500	
			0 / 692		0 / 5700		0 / 10550		20000 / 32050	20000	-40000 / -27500	STEP A
			0 / 692		0 / 5700		13750 / 24300	13750	-27500 / 4550		27500 / 0	STEP B
			0 / 692		-4550 / 1150	-4550	9100 / 13600		-4550 / 0		0 / 0	STEP C
			-33400 / -32708	-33400	66800 / 67950		-33400 / 0		0 / 0		0 / 0	STEP D
	-67950		135900 / 103192		-67950 / 0		0 / 0		0 / 0		0 / 0	STEP E
	103192		-103192 / 0	103192	0 / 0	103192	0 / 0	103192	0 / 0	103192	0 / 0	STEP F
0	0	35242	0	69792	0	98642	0	116942	0	123192	0	TOTAL

TABLE 3—Simplified Relaxation Diagram

	POINT 1		2		3		4		5 (E)	
0	0	0	692	0	5700	0	10550	0	12050	0	2500	
									32050	20000	-27500	
							24300	13750	4550		0	
					1150	-4550	33400		0			
			-32708	-33400	67950		0					
		-67950	103192		0							
		103192	0	103192	0	103192	0	103192	0	103192	0	
0		35242	0	69792	0	98642	0	116942	0	123192	0	

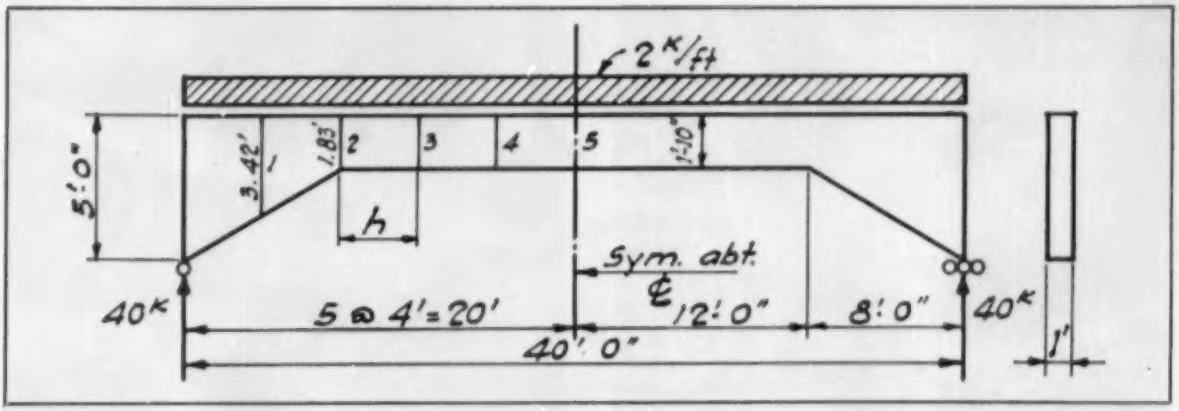

FIGURE 4—Haunched concrete beam.

In order to speed up the relaxation process it is sometimes convenient to apply increments to more than one point at the same time. This is known as *block relaxation* and the block operators are obtained by superposition of the point relaxation pattern given in Figure 2a.

The beam solved in this article is symmetrical, and to avoid duplication of effort we may work on half the beam. It is only necessary to remember that in displacing a point adjacent to the line of symmetry, the similar point on the other side of the line is displaced by a like amount. Thus the effect on the center point of the beam would be a positive unit displacement from its two adjacent points. The symmetrical pattern is shown in Figure 2b.

Figure 3 gives the block operators for two, three, four and five point displacements, taking into account the symmetry of the beam.

Numerical Example—Figure 4 shows a simply supported haunched concrete beam with a uniform load of 2 kips per foot, for which the deflection curve is required. The beam is divided into ten sections, four feet long. The quantities $\frac{Mh^2}{I}$ for the five symmetrical points are calculated in Table 1. Since E is constant for the beam, it may be left out in determining the values of w.

The process of liquidation of the residuals is carried out on a relaxation diagram in Table 2. The table consists of a diagrammatic representation of one-half the beam divided into the five intervals. To the left of each subdivision are recorded the values of w and to the right the corresponding residuals. At the support, the value of w which is known to be zero, is recorded.

A study of Figure 3 shows that a five-point block operator has an effect of —1 on the residual of the point adjacent to the boundary, while it causes no displacement at the other points. It is apparent, then, if displacements are used which set the residuals at points 2, 3, 4 and 5 equal to zero, the residual at point 1 can be liquidated by application of the five-point block operator.

Referring to Table 2, start with an arbitrary displacement at point 5 of w = 20,000. Using the point operator of Figure 2a results in a change in the residual of —40,000 at Point 5 and +20,000 at Point 4. Step A records the displacement, its effect on points 5 and 4 and the algebraic sum (the residual after Step 1) of the original residual and the first displacement. Thus, the residual at Point 5 has been changed from 12,500 to —27,500 and at Point 4 from 12,050 to 32,050. To change the residual at Point 5 to zero, apply the operator of Figure 2b to Point 4 with a displacement of $\frac{-27,500}{-2} = 13,750$. The changes due to this displacement are recorded in Step B. In Steps C, D and E the operator of Figure 2 is used to set the residuals of points 4, 3 and 2, respectively, equal to zero. In Step E, the only remaining residual is +103,192 at Point 1. By applying the five point group operator of Figure 3 with a displacement of +103,192, the relaxation is completed. The final w at each point is the sum of the increment displacement at the point and these are given in the "total" line of Table 2.

After the computer has gained some familiarity with the method, the relaxation diagram may be condensed as shown in Table 3.

The deflection at any point can now be determined by dividing the value of w by E and converting to the proper units. Using a modulus of elasticity, E, equal to 3×10^6, at the center, the deflection $= \frac{123.192 \times 1000}{3 \times 10^6 \times 144}$

$= 0.285$ ft.

Meet the Author

GEORGE J. FEINMAN, as a project engineer with James P. O'Donnell, a New York and Beaumont, Texas, engineering firm, has designed and supervised the design of major structures and substructures for oil companies both in the U. S. and other countries.

Feinman

Before joining the O'Donnell organization in 1948, he was a structural designer with Foster-Wheeler Company. Previously, he had been connected with Babcock & Wilcox Company and during World War II, served as a civil engineering officer attached to the Seabees. A graduate of the College of the City of New York, he holds a cum laude degree in civil engineering. A previous Feinman article appeared in the PETROLEUM REFINER in July, 1954.

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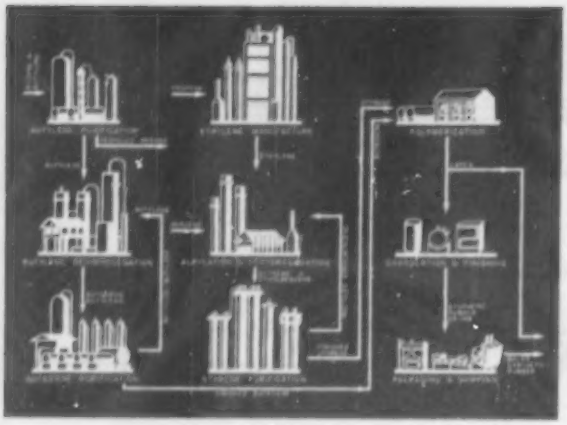

Flow sheet shows facilities at Torrance, Calif., which Shell Chemical Corporation purchased from the federal government for $30 million. The plant produces one-eighth of nation's capacity.

A handful of synthetic rubber "crumb" is lifted from the soapy solution as it comes from the coagulator unit. The "crumb" is further filtered, washed, shredded, dried and baled before shipment.

What Shell Bought

FOR $30 million, Shell Chemical Corporation became the sole owner of the federal government's 12-year-old synthetic rubber plant at Torrance, Calif. The plant produces one eighth of the nation's synthetic rubber capacity (90,000 long tons per year).

At the outset of World War II when the natural rubber shortage crisis threatened, Shell contributed its patents and "know-how"; and at the federal government's request, the butadiene plant was built and operated. Five other companies were involved jointly with the early history of Torrance synthetic rubber facilities: The Dow Chemical Company, Goodyear Rubber Company, Standard Oil Company of California, Southern California Gas Company, and U. S. Rubber Company. More recently Standard Oil, Dow, Midland Rubber Company, and Shell have operated the government-owned plants.

Shell Chemical Corporation became the sole operator of the plant in April, 1955, when the United States Congress directed that the facilities be sold to private industry.

Torrance Plant Processes—Synthetic rubber is the principal product emanating from the Torrance plant, synthetic rubber being made of butadiene and styrene.

Butadiene—Butadiene is produced at Torrance from butylene by splitting off from the butylene an equal volume of hydrogen gas.

In the first step of the butadiene process, crude feedstocks are purified by distillation and extraction. Both processes are combined in one large distillation column. In the second step, a small amount of butadiene contained in purified feed is extracted in a solution of copper, ammonia, and acetic acid. In the third step, the unextracted butylenes are dehydrogenated to additional butadiene. The crude butadiene produced in this step is returned to the extraction unit for purification of the butadiene content.

Two other processes are performed at the Torrance butadiene unit. One of these processes is the adsorption of isobutylene from the feedstock in 65 per cent sulfuric acid. The other process is the distillation of isobutane from butane.

Styrene—Materials required for styrene production at Torrance are propane and benzene. The first step of the process is cracking the propane feed by subjecting it to very high temperatures to produce ethylene. In the second step, the ethylene is reacted with benzene to produce ethylbenzene. In the third step, the ethylbenzene is dehydrogenated to produce styrene. In the fourth step, styrene is purified by distillation performed under vacuum.

Copolymer—The GR-S rubber produced in the copolymer unit is quite similar in appearance and performance to natural rubber. The heart of the copolymer plant process is the copolymerization of the two chemical building blocks—butadiene and styrene. In this process, the two chemicals unite together, with each other and with themselves, to form the elastomer, GR-S rubber.

One pound of GR-S rubber requires about one-fourth pound of styrene and about three-fourths pound of butadiene. These chemicals, together with smaller amounts of other chemicals, are emulsified in large volumes of soap solution. The reaction takes place in this solution. After 11 to 17 hours, the reaction is stopped, and unreacted butadiene and styrene are removed from the solution.

At this point, the solution is called "latex" and some is sold in this form. However, most of it is treated to coagulate and recover the rubber from the solution. First, blending agents are added. Then, the rubber is converted into "curds" in the solution by addition of brine and sulfuric acid. Finally the coagulum, or "curd" is filtered, washed, shredded, dryed, baled, and stored on pallets. ##

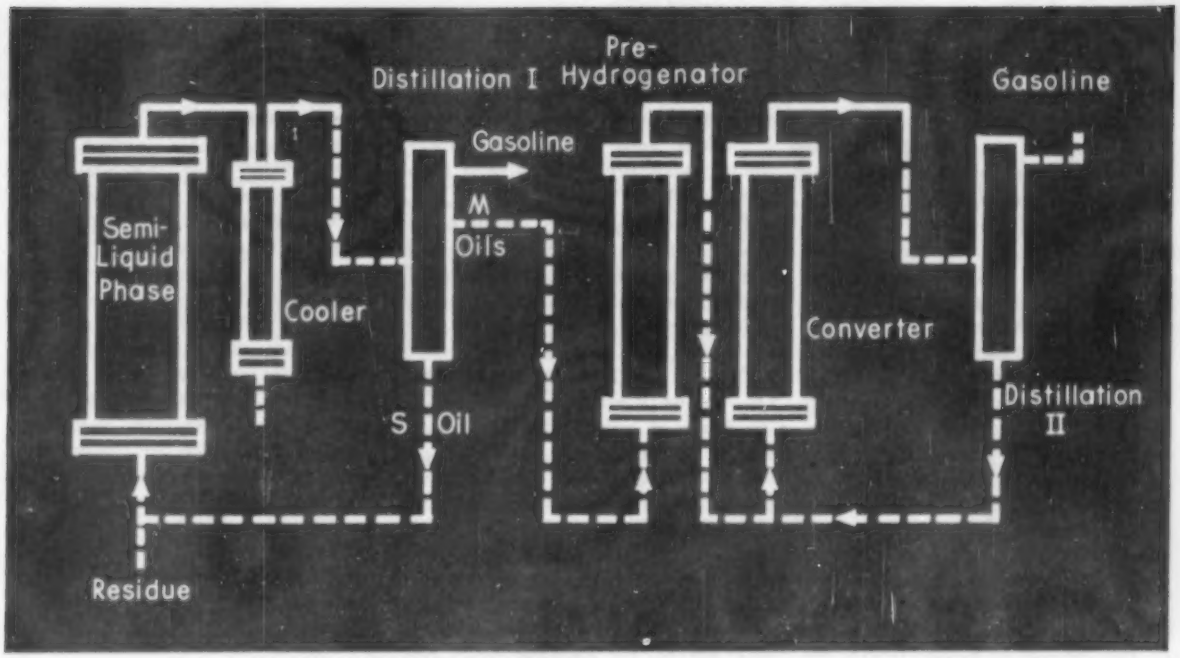

FIGURE 1—Equipment sequence for use in catalytic pressure hydrogenation.

New Developments in Hydrogenation

Here are the results of German work on hydrogenation of petroleum under pressure using new catalysts.

W. Oettinger,
Badische Anilin & Sodafabrik AG, Ludwigshaven, Germany

THE PROCESSES developed to date in the hydrogenation of petroleum under pressure should be viewed as capable of many further improvements. Advances in this technology comprise greatly simplified procedures and also the development of new and rugged catalysts.

New procedures which have been evolved are described in the following discussion. They have been in commercial operation for over one year and the results are most satisfying.

Former Operations of the plant—When operations were first resumed a few years ago at the Gelsenburg and Wesseling plants it was necessary to suit these operations to the methods formerly employed and also to the equipment at hand. This equipment had been in operation for hydrogenating oils and tars, and for the so-called "liquefaction of coal." Crude oils were first topped to gasoline, gas-oils and a reduced residuum. The latter a residue boiling over 680 F. is next processed or cracked in semi-liquid phase, shown in Figure 1. Finely divided catalyst, pitchy material, and very high boiling oils are withdrawn from the bottom of the cooler and stripper gases and oil vapors from the top of the latter are the feed stock to the first distillation tower after cooling and after reduction in pressure. This tower may be viewed as a separator tower or stripper for very heavy ends.

The effluent from the reactor or the feed to the separator-tower contains about 55-65 percent gasoline and intermediate gas-oil with an end-point of about 680 F. Gasoline is taken off overhead, and gas-oil or "M-oil" passes to a preliminary hydrogenation tower, and then to the hydroforming cycle for further conversion to light distillate. Vapor-

This article has been translated from the German by Edwin J. Barth, petroleum consultant, Northampton, Mass. It originally appeared in Erdoel u. Kohle, No. 11, 1953.

phase heavy oil (the "S-oil") boiling above 680 F. is recycled back to the reactor.

Existing equipment had to be adapted to the new Mid-East and also German crudes, containing some 20-50 percent gasoline plus diesel and distillates. These crudes are high in sulphur, low in asphalt content, and are in general quite paraffinic.

In trying to adapt these newly discovered hydrogen-rich crudes to the early procedure shown in Figure 1, it soon became evident that several changes had to be made. The alternative was that the knock-type topped gasoline from these crudes, being very low in octane number, would have greatly depressed the hydrogenated product in any mixture with it.

Two Main Problems—The necessity for procedural changes gave rise to two problems. Research and development work was carried out in the labs and hydrogenation plants of the Badische Aniline Company in Ludwigshaven, Germany.

The first problem was to determine the effects of passing the heavy reactor oil or "S-oil" containing the added medium gas-oil ("M-oil") directly to a fixed bed catalyst tower instead of returning it to the reactor. By such a procedure, the throughput of topped crude oil residue to the semi-liquid phase reactor could be increased by an amount equal to the recycle stream of heavy reactor oil. A similar increase in distillation capacity would result. In addition, the processing of heavy distillate through a modern fixed bed catalyst tower would mean greatly improved gasoline quality.

The second problem which arose was that of finding new and improved catalysts to obtain high anti-knock from the new paraffin-rich crudes of the Middle East.

Problem No. 1—Cracking the Gas-Oil—In work with the cracking of the heavy gas-oil, it was found that, with a once-through, or so-called direct throughput, the product from the tar or stripper tower, containing about 50 percent of heavy oils, boiling over 660 F. could be converted not only into lighter gas-oils, but also substantially into gasoline. The tar-tower or separator tower overhead was fed to the catalyst fixed bed tower using pressures of 600 atm. and a catalyst built up on bleaching clay. Using a gasoline-free heavy tar separator oil as feed, a 50 percent yield of gasoline was secured in a once-through operation at 600 atm. In earlier tests on cracking the heavy gas-oil, only the unconverted or uncracked heavy oils were recycled back into the system. It was now found most advantageous to return all fractions boiling above the gasoline range. By this means the total tar separator butts were converted substantially to gasoline.

Differences in physical properties between a topped crude and gasoline-free tar butts product are seen in Table 1.

Note that these separator butts contain some 50 percent of material boiling up to 660 F. in contrast to the topped crude or residue containing no medium or middle oil cuts. These butts, at 600 atm., were easily split over suitable catalysts in a once-through operation as well as when recycling the material boiling somewhat over 356 F. The results are shown in Table 2.

TABLE 1
Semi-phase Hydrogenation of Crude Residue

	Crude Residue	Semi-Phase Stripper Product (Gasoline-Free)
Spec. Gravity, 20° C	0.935	0.870
Initial Boiling Point, °F.		200
Weight Percent, up to 662 F.	0	48
Vacuum-Residue over 617 F., 15 mm. Hg.	52.2%	26.0%

TABLE 2
Heavy Oil Cracking At 600 ATM

METHOD	Once Through	Recycling Oils Over 356 F.B.P.
Reaction Temperature (°F.)	800	800
Thruput Kgm/Liter/Hour	0.8	1.0
Gasoline Concentration (%) in Stripper Product	50	50
Properties of Gasoline:		
Spec. Gravity, 60 F.	0.735	0.730
Volume Percent Up to 212 F.	38	40
Octane Value:		
Motor Method	60	60
Motor Method +0.04 Vol. Percent TEL	72	72
Product Over 356 F.		
Specific Gravity	0.813	.....
Percent to 662 F. (Engler)	93	.....

The gasolines so derived from both operations show little difference between them. They are highly purified and show an excellent lead-susceptibility.

Here is the procedure used at the hydrogenation plant in Wesselring in the direct cracking of heavy gas-oil. A vacuum distillation is prepared from the reactor heavy oil. This is blended with reactor medium gas-oil and converted to gasoline through a fixed bed catalyst at 550 atm. In these heavy oil operations the clay-based catalyst proves very efficient at pressures over 400 atm. For use at pressures below 300 atm. new catalysts are used which are composed of synthetic aluminum silicates and the oxides or sulfides of molybdenum tungsten or other heavy metals. At the Scholven plant now the total stripper butts are converted to gasoline and diesel oil at a pressure of 300 atm.

Combined operation—It is also very feasible to place the catalyst tower directly after the reactor—that is, to pass the reactor gases and vapors from the exchangers directly to the fixed bed catalyst tower, without undue condensation. The preliminary pilot plant tests indicating good operations are now in plant use.

A simplified scheme of the combined operations is shown in Figure 2 on next page.

In the combined operation reduced or topped crude is hydrogenated in semi-vapor phase in a once-through or direct operation, the products entering Coolers I and II, where finely divided catalyst and high-boiling oils are withdrawn at the bottom. Gases and products in vapor form pass overhead directly to the fixed bed cracking catalyst unit. The product formed in the high pressure catalytic tower passes next to re-run units where gasoline and diesel gas-oils are obtained.

The Scholven plant has been in operation now one and one-half years and has fulfilled all expectations. Pilot plant results are well duplicated on the commercial scale. By placing the fixed bed catalyst tower directly behind the reactor—in a so-called combined operation, considerable savings in energy or BTU unit requirements and increased distillation capacity are realized.

TABLE 3
Hydrogenation Oil Residues

Product from	Semi-Liquid Phase	Combined Procedure	Combined Procedure Latest Catalyst
Spec. Gravity, 20° C.	0.836	0.796	0.786
Weight % Up to 365 F.	14.0	32.0	42.0
Weight % 365 F.-662 F.	44.5	56.0	51.0
Weight % over 662 F.	41.5	12.0	7.0

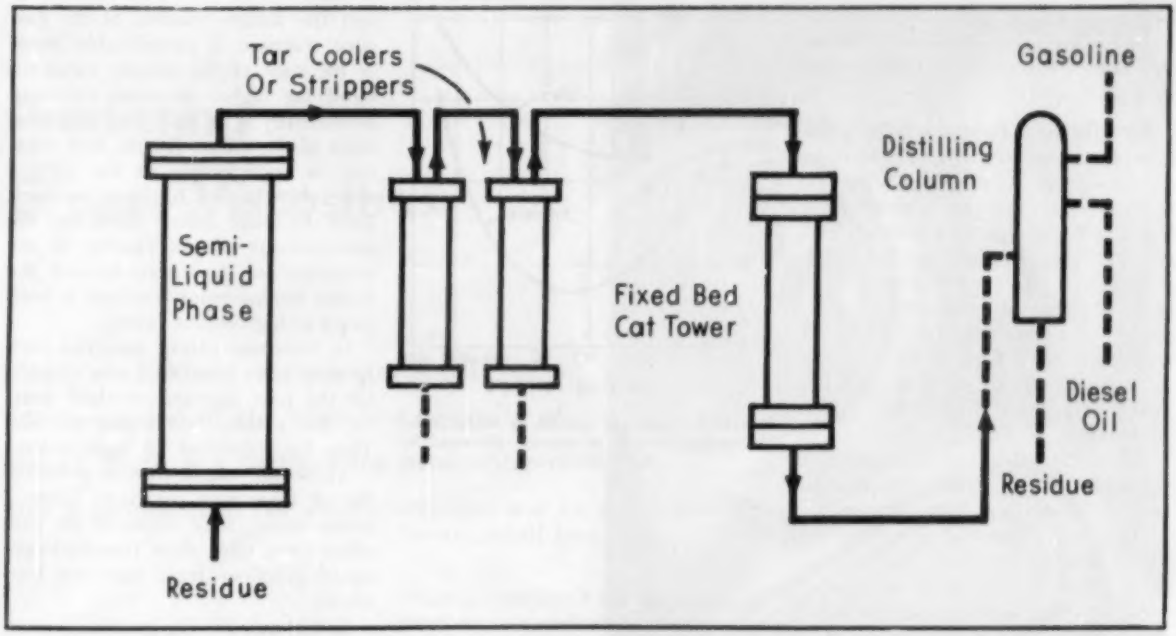

FIGURE 2—Flowsheet for "combined operations" process.

Table 3 shows the properties of products obtained in the semi-liquid phase hydrogenation of a topped German crude in a once-through operation by the earlier procedure and also by the combined operation, using the same reduced crude.

Results with two different catalysts are given in the Table for the "combined procedure." One will note the greatly lowered yield of gas-oils boiling over 662 F. with the latest catalyst. Especially noteworthy is the fact that these products are absolutely free of sulfur and nitrogen in contrast to the straight hydro-cracked products.

Our efforts in the direct cracking of heavy oils originated in trying to simplify the catalytic pressure hydrogenation of oils rich in paraffins. Simultaneous efforts were also made to obtain some sort of selective refining operation of the products formed in the reactor.

Sulfur, oxygen and nitrogen compounds present in the raw feed are reduced barely two-thirds in the vapor reactor. In contradistinction, the final product from the fixed bed hydrogenation towers are almost free of these constituents—an indicator of the degree of purification of these fractions. The semi-liquid phase products, in other words, require additional treatment.

Desulfurization—The removal of sulfur from gasoline and diesel fuels derived from topped crude products is most desirable. High sulfur content in crudes and its lower-boiling-products is detrimental. Hydrogenation is versatile and readily adaptable to secure far-reaching desulfurizations. A fair number of efficient and especially suited catalysts are available depending on the type of raw feed to be processed, and degree of purification desired. With such catalysts hydrogen pressures may be varied over a wide range depending on operating conditions.

In efforts to find catalysts for upgrading the semi-vapor cracked crude products, many were found to be quite selective in their action. Sulfur, nitrogen and oxygen compounds are almost completely removed, without a second cracking treatment being necessary.

The hydrogenation of these compounds and other hydrocarbons susceptible to hydrogenation reactions affects a lowering of the molecular weight of the total mix. In direct ratio to the lowered molecular weight there is a decrease in the boiling-point, or a lower boiling-point curve. In this work on the refining of semi-vapor cracked gasolines, as well as those from the splitting of medium and heavy gas-oils, hydrogen pressures of 50 atm. or less were employed. Producer gases and others

TABLE 4
Desulfurization of Gas-Oil

% Desulfurized	70%	94%	Straight Run Gas Oil (Orig.)
Spec. Gravity, 60 F.	0.827	0.823	0.833
Aniline Point (°C.)	70.5	70.8	69.5
Initial Boiling Point (Engler)	390 F.	369 F.	396 F.
Vol. % up to 437 F.	12	15	11
Vol. % up to 572 F.	71	72	69
End-Point (F.)	662	662	662
Sulfur (Percent)	0.22	0.04	0.75

TABLE 5
Desulfurization of Aramco Gas-Oil

Percent Desulfurization	65	75	Aramco Crude (Original)
Specific Gravity	0.841	0.835	0.849
Aniline Number (°C.)	74.	73.	72.5
Boiling Points:			
Weight percent to 392 F.	18.9	19.5	18.5
Weight percent to 662 F.	64.0	67.5	62
Percent Sulfur	0.48	0.35	1.4

TABLE 6
Conversion of Gas Oil

CATALYST	6434	Silicate Type
Gasoline Produced:		
Specific Gravity	0.715	0.723
Volume % Up to 212 F.	47	45
End-Point (°F.)	374	374
Weight % Aromatics	8	17.5
Octane Value:		
1.Motor-Method	69	72
Motor-Method Plus 0.04% Volume of TEL	76	83
2.Research-Method	64	74
Research-Method Plus 0.04% Volume TEL	77	85

rich in hydrogen may be used instead of pure hydrogen.

Straight Run Products—The purification and desulfurization of straight run products is of present-day interest. Below is given a description for desulfurizing a straight run gas-oil and also Aramco crude, as an example of catalyst efficiency.

A straight run gas-oil, 0.75 percent S, was desulfurized at 50 atm. at a thruput of 2 Kgm/l. catalyst per hour; hydrogen to oil ratio was 0.2 cu. meters/Kgm. Results are given in Table 4.

After two months of continuous operation a 90 percent reduction in sulfur contents was still obtained.

Aramco crude was refined or hydro-fined at 50 atm.; at the end of a 150-hour run, 60-70 percent of total original sulfur was still being removed. Table 5 shows the results at both levels of sulfur reduction.

Reduced crudes and heavy gas-oils can be similarly treated.

Problem No. 2—Improving the Octane Rating

The second part of the over-all program undertaken was the development of new and improved catalysts for increasing the octane rating of the gasoline product. During the development of the synthetic aluminum silicate based catalysts for cracking heavy oils, it was noticed at once that catalysts containing the heavy metals and when specially prepared produced gasoline of unexpectedly high octane values. This information was of value not only for cracking high boiling-point oils, but it led to new catalysts, useful in splitting medium type gas-oils, giving us so-called "gasoline-forming" catalysts.

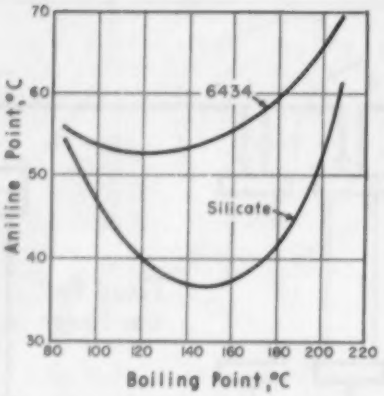

FIGURE 3—Hydrogen content as measured by the aniline number of gas-oils processed by hydro-conversion.

These catalysts are now employed for both heavy and light gas-oil cracking.

Comparing the Catalysts—Quality improvement with these new catalysts is seen by inspection of tests in Table 6. Here Aramco straight run gas-oil was cracked with the old catalyst 6434 and with the new improved type. One will note the high octane values of gasolines which are low in hydrogen when using the newly developed silicate type catalysts. Gasoline yields are only slightly decreased, with gas formation correspondingly higher. Increase in octane value is due mainly to the higher aromatic content. Isoparaffins are also higher.

The higher aromatics content is very evident when compared with the hydrogen content of similar cuts. As a measure of paraffinicity, or hydrogen content, the aniline number method was used. The values were determined on 20-degree (°C) boiling-point fractions. The results are shown as a set of curves in Figure 3.

An inspection of the curves shows that the aniline number of the gasoline fractions is considerably lower in the case of the silicate catalysts, signifying higher aromatic contents. Noteworthy is the fact that the minimum of the curve, for the new catalyst, is considerably to the right—noticeably in the higher fractions. Both the lower aniline curve and the simultaneous displacement of the minimum of the curve toward the higher boiling-point fractions is indicative of high octane rating.

In both our plants, catalysts such as these have been used now steadily for the past one and one-half years for the middle and heavy gas-oils. They have fulfilled all expectations.

There are many further possibilities of these new catalysts. Table 7 below shows tests obtained on gasolines from pilot plant runs-hydrogenated gasolines from various feed stocks.

In Column 1—The gasoline formed from Aramco straight-run gas-oil.

Column 2—A gasoline from the hydro-cracking of a semi-liquid phase of middle gas-oil, previously hydrogenated. The original raw stock is a reduced crude.

Column 3—A gasoline from a prehydrogenated middle gas-oil derived from semi-liquid phase cracking residuum, where crude oil is feed stock.

Column 4—A gasoline from the same raw stock, and from the same semi-vapor phase operation—but where the prehydrogenation of this middle gas-oil was conducted with a newly developed catalyst.

Column 5—Shows the tests of a gasoline obtained by hydro-cracking a gas-oil from thermal cracking operations.

In the hydro-cracking of these medium type gas-oils obtained in catalytic cracking, gasolines are obtained very similar in properties to those obtained from the cracking of thermal gas-oils.

Quality of these various hydrogasolines is naturally dependent on the variable or conditions set up for in the process.

The above data were obtained from close coordination between the various research groups, working with pilot plant equipment. Much valuable exchange of information was carried between these groups and the commercial plants.

ACKNOWLEDGMENT

We thank Professor M. Pier for his many valuable suggestions and stimulation during these investigations.

TABLE 7
Hydro-Conversion of Petroleum Stocks

Raw Feed-Stock	Aramco Gas-Oil (1)	Semi-phase Medium Gas-Oil Reduced Crude pre-hydro-genated (2)	Semi-phase Medium Gas-Oil From Cracking Residue, pre-hydro-genated (3)	Same Stock as in Column (3) but with Very Recent Catalyst (4)	Medium Gas-Oil From Thermal Cracking (5)
Gasoline:					
Specific Gravity, 60 F	0.723	0.723	0.735	0.745	0.778
Volume percent up to 212 F	45	42	42	42	30
End-Point (°F.)	374	374	374	374	374
Weight percent aromatics	17.5	17.0	18.0	28.0	45.
Octane Value:					
1. Motor method	72	70	73	76	78
Motor method plus 0.04 volume percent TEL	83	81	84	85	85
2. Research Method	74	72	75	82	88
Research method plus 0.04 volume percent TEL	85	83	86	91	94

Predicting Grease Viscosities

Many specifications call for a determination of the apparent viscosity of grease. Here is a method for measuring it and a nomograph for predicting it.

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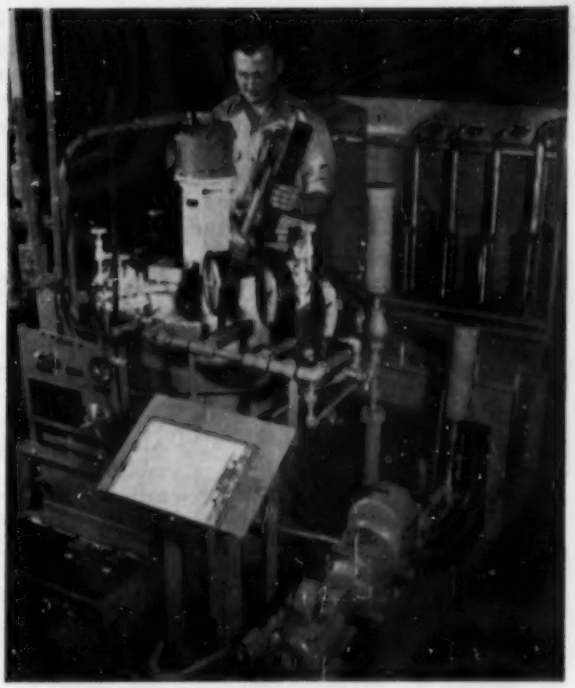

FIGURE 2—Size and arrangement of various parts of the pressure viscometer.

APPARENT VISCOSITY has become widely recognized as an excellent means of characterizing the flow properties of lubricating greases. Industry has found it useful because it correlates well with pumpability, and it has been used by the government and armed forces in describing greases for low temperature services. Almost without exception, specifications for lubricating greases designed for low temperature service contain apparent viscosity requirements.

Unfortunately, the use of apparent viscosity to characterize the flow properties of greases over a wide range of temperature has developed more rapidly than has the standardization of the method of measurement. Although many specifications contain apparent viscosity requirements, particularly at low temperatures, there is no widely accepted apparatus or procedure for the determination of apparent viscosity at temperatures other than room temperature.

With the thought of facilitating the establishment of a standardized method, the apparatus and procedure used at California Research Corporation is described here. Also reported are some data developed with the aid of a statistical method, which show quantitatively the dependency of apparent viscosity on:

1. Soap content
2. Viscosity of the mineral oil
3. Worked penetration of the grease.

With the aid of this correlation in the form of a nomograph, the apparent viscosity of the grease can be calculated quickly.

Pressure Viscometer Apparatus—A schematic diagram and a photograph of the pressure viscometer apparatus are shown in Figures 1 and 2, respectively. The principal features of the apparatus are (1) location of the metering pump outside the constant temperature bath, (2) circular, constant temperature bath to hold six test cylinders mounted vertically, and (3) provision for direct measurement of the rate of flow of the grease.

The location of the pump outside of the bath has one particular advantage, ready accessibility for maintenance and repair. In order to minimize slippage at high operating pressure, the pump is charged with an oil having a viscosity of 500 SSU at 100 F. As shown in Figure 1, the viscous oil is pumped into a closed cylinder containing a floating piston by means of which the pressure is transmitted to the usual light hydraulic oil. Before the piston reaches the top of the cylinder, the pressure on the system is released, the valve to the reservoir above the cylinder opened, and a steel rod inserted to force the piston back to the bottom. The location of the piston can be judged at all times by the level of the viscous oil in the reservoir.

The pressure on the system is measured in the conventional manner by three precision bourdon gages covering the ranges of 0-800 psi, 0-2000 psi, and 0-5000 psi. Each gage is connected to the system through an automatic shut-off valve, which prevents the gage from being subjected to pressures beyond its capacity.

The circular design of the constant temperature bath permits ready accessibility to the six test cylinders which are mounted vertically around the periphery of the bath. The circulation system, which is in the center of the bath, consists of two 3-inch, pitched propellers located inside of a section of 6-inch pipe and connected to a one-quarter horsepower electric motor. The adequacy of the circulation system is indicated by a temperature gradient in the vicinity of the test cylinders and capillaries of less than 0.1 F. at —65 F. For low temperature operations, dry ice is used as a coolant and denatured ethyl alcohol as the cooling medium. The basket for the dry ice is located in the center

of the bath, as indicated in the schematic diagram. At elevated temperatures, a suitable mineral oil is used in the bath. The temperature is measured by a copper-constantan thermocouple connected to a precision potentiometer, which is periodically checked against a recording resistance thermometer calibrated by the U. S. Bureau of Standards. The temperature is controlled by a bimetallic regulator connected to a 1000-watt heater. Additional heaters are inserted in the bath for operation at elevated temperatures.

As shown in Figure 1, the reservoir above the capillary is connected to a burette, and this system is filled with a suitable liquid, which for low temperature tests is denatured alcohol. The grease forced through the capillary displaces an equal volume of the liquid at the test temperature which can then be measured in the burette at room temperature. In order to determine the correction for the volume change due to expansion or contraction, the displaced liquid is passed through a heat exchanger, thereby adjusting its temperature to room temperature.

The usual method of determining flow rates depends on precalibration of the pump and on occasional checks. Direct measurement of flow has the big advantage that it eliminates possible errors due to unknown changes in calibration, leaks in the system between the pump and the capillary, and unknown slippage within the pump, especially at high pressure. The last-named effect is recognized by the present ASTM method in that calibrations are made at high discharge pressures.

Procedure for Determination—Briefly, the procedure for the determination of apparent viscosity is as follows: The grease cylinders are filled carefully to minimize entrapped air and inserted in the constant temperature bath, as shown in Figure 1. After a suitable length of time to permit the grease to reach the specified temperature, the test is started. For low temperature tests, as required by most military specifications, the bath is cooled to the test temperature in approximately two hours after the insertion of the grease cylinders, and an additional two hours is allowed to elapse before the test is started. By means of a speed reducer, the speed of the metering pump is adjusted to maintain a desired pressure on the system. After the system reaches equilibrium, the volume of liquid displaced into the burette by the grease forced through the capillary is measured over a suitable time interval. Following appropriate adjustment of the volume for expansion or contraction, the rate of flow of the grease is calculated and expressed in cubic centimeters per second. To cover the desired range of shear rates, measurements are made over an appropriate range of pressures.

Relationship Between Apparent Viscosity and Other Grease Properties—It has been shown previously[1,2,3] that the apparent viscosity of a lubricating grease prepared with a given type of thickener (usually a soap) is dependent upon one or more of the following properties: (1) viscosity of the mineral oil, (2) concentration of the soap, and (3) consistency of the grease. In general, however, the relationships established between the above properties and apparent viscosity have been only qualitative. It is evident that a quantitative relationship capable of predicting apparent viscosity with reliable accuracy would be a valuable aid in the manufacture of greases which must comply with specified apparent viscosity requirements. This type of relationship for apparent viscosity at —65 F has been developed for a lithium-calcium base grease which is qualified under Automotive and Artillery Grease Specification MIL-G-10924 (ORD), Amendment 1. A few greases of the same type, but in which large deviations were purposely made are also included.

The relationship which was developed with the aid of punched cards is as follows:

$$AV = 6200 - 85P + 1020S + 305V$$

Where AV = Apparent viscosity, poises at 25 sec.$^{-1}$ and —65 F.

Meet the Authors

J. L. DREHER, connected with California Research Corporation since 1945, has held technical positions in a variety of chemical projects. He joined General Petroleum Corporation in 1935 and remained with its technical departments until 1943, when he left to join the atomic bomb project then underway at the University of Chicago. Since then he also has worked at Hanford Engineering Works in Richland, Wash. Dreher graduated in chemistry from the University of California.

C. F. CARTER, for the past 15 years engaged in the development and manufacture of lubricating greases, has been with California Research Corporation, a subsidiary of Standard Oil of California, since shortly after his graduation from college in 1934. He is an engineering graduate from Polytechnic College of Engineering.

E. B. REID, head of the Mathematical Services group for California Research Corporation, has been with the company since 1939, except for the war years which he spent with the Army's Chemical Warfare Service. A University of California graduate in chemistry, Reid completed graduate studies at the University of Michigan where he received both his master's and doctor's degrees. He is a member of ACS, Sigma Xi and Phi Lambda Upsilon.

P = ASTM worked penetration
S = Soap content, percent by weight
V = Viscosity of the mineral oil, SSU at 100 F.

The above equation, which was derived by the method of least squares,[4] is based on data obtained from 62 batches of grease, in which the worked penetration varied from 310 to 349, the viscosity of the mineral oil from 69.8 to 132.0 SSU at 100 F, the concentration of soap from 7.8 percent to 12.6 percent by weight, and the apparent viscosity from 7600 to 30,000 poises.

A nomograph based on the above equation by which the apparent viscosity can be quickly calculated is shown in Figure 3. By means of this nomograph, the manufacture of a batch of grease can be accurately controlled so that the finished product will readily comply with the apparent viscosity requirements. For example, it can be determined from the chart that a grease containing 10.6 percent soap and a mineral oil with a viscosity of 73.0 SSU at 100 F and having a worked penetration of 281 has an apparent viscosity of 15,500 poises. If the maximum limit is 15,000 poises, additional oil must be added. From experience, it is known that sufficient oil to lower the soap content to 9.6 percent will increase the worked penetration to 295. According to the nomograph, the apparent viscosity of the resultant grease is 13,200 poises, well within the maximum limit.

Reliability of the Correlation—Statistically, the reliability of the above equation can be estimated in two ways: by the standard deviation and by the coefficient of determination. The standard deviation, which is an indication of how closely a given determination can be estimated, is calculated by the following equation:

$$\bar{S} = \sqrt{\frac{\Sigma d^2}{n - m}}$$

Where $\bar{S}$ = Standard deviation (sometimes called standard error of estimate).
d = Difference between the measured and computed values.
Σd^2 = Sum of the squares of all the differences.
n = Number of points of data, which in the above correlation is 62.
m = Number of constants in the equation, which in this case is 4.

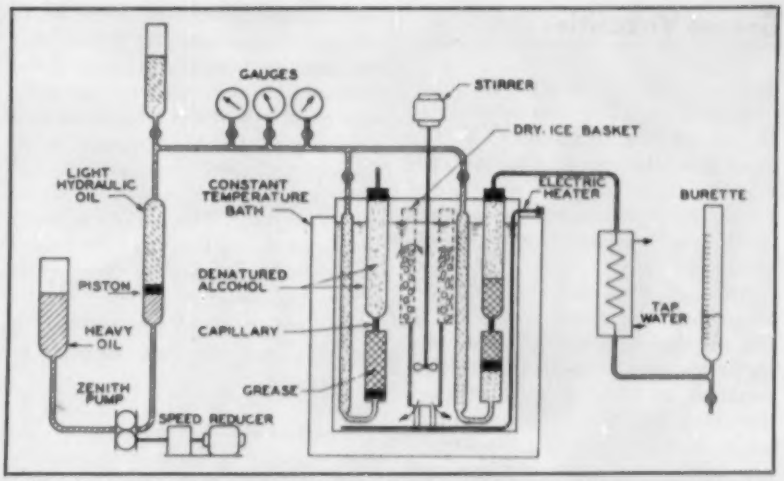

FIGURE 1—Schematic diagram of the pressure viscometer used to determine apparent viscosity.

The standard deviation is of value in establishing the reliability of a given correlation because from it "confidence limits" can be set. For example, it can be shown statistically that one half of the results of a given set of determinations will not differ from the results calculated by the correlation by more than 0.674 $\bar{S}$. Therefore, 0.674 S is called the 50 percent confidence limit. Also, it can be shown[5] that the 67 percent, 90 percent, and 95 percent confidence limits are 1.00 $\bar{S}$, 1.65 $\bar{S}$, and 1.96 $\bar{S}$, respectively.

In the case of the above correlation, the standard deviation, $\bar{S}$, is 1380. From this value the confidence limits of the correlation can be calculated and are given in Table 1.

TABLE 1
Confidence Limits of Apparent Viscosity Correlation

Confidence Limits, Percent	Poises
50	930
67	1380
90	2280
95	2710

On the basis of the values in Table 1, it can be stated that if 100 more determinations were to be made, 50 or one-half of the results would be within 930 poises of the predicted values, and 95 would be within 2710 poises of the predicted values. It is of considerable help to the grease maker to be able to predict the apparent viscosity of 95 percent of his batches of grease within 2710 poises.

The coefficient of determination is an indication of the reliability of the correlation because it is a measure of the extent to which all variables are accounted for. For example, in the above correlation it is assumed that the important variables influencing the apparent viscosity are soap content, viscosity of the mineral oil, and worked penetration. If these three properties were not the most important ones, the coefficient of determination would approach zero. If, on the other hand, they are the most important ones and the data are reasonably accurate, the coefficient would approach unity.

The formula for the calculation of the coefficient of determination is as follows:

$$\text{Coefficient of Determination} = 1 - \frac{(\bar{S}_e)^2}{(\bar{S}_a)^2}$$

Where $\bar{S}_e$ = Standard deviation about the correlation.
$\bar{S}_a$ = Standard deviation about the average.

It can be seen from this equation that if the correlation is perfect, S_e is zero, and the coefficient is one. On the other hand, if the correlation is very poor, $\bar{S}_e$ approaches $\bar{S}_a$. Consequently, $(\bar{S}_e)^2/(\bar{S}_a)^2$ approaches one, and the coefficient will be amost zero. In general, the smaller the range of variation of the variables, the poorer will be the coefficient of determination because the experimental errors become a greater part of the variation.

In the case of the above correlation, the coefficient of determination is 0.82. This means that 82 percent of the variation in apparent viscosity is accounted for by variations in the selected three independent variables of soap content, viscosity of the mineral oil, and worked penetration. In view of the relatively narrow range of variation of these three variables, the establishment of a correlation with a

coefficient as high as 0.82 is considered excellent. The unaccounted for 18 percent can be attributed to (1) other independent variables not considered, (2) inadequate selection of the means of measuring the variables which were considered, and (3) experimental errors.

Although there may be properties other than the three considered in this correlation which affect the apparent viscosity, a coefficient of determination as high as 0.82 indicates that they are not of major importance. In this connection, an attempt was made to correlate the apparent viscosity with only soap content and viscosity. In this case, the coefficient was 0.78, and the standard deviation was 1525, as compared to 1380 in the previous case when penetration was considered. These values show that apparent viscosity is affected by the worked penetration, although not to a marked extent.

A large portion of the unaccounted for 18 percent is probably due to the inadequate selection of the means of measuring the variables which were considered in the correlation. Undoubtedly, a better coefficient would have resulted from the use of the viscosity of the mineral oil at — 65 F, the test temperature for determining the apparent viscosity, instead of the viscosity at 100 F. Although the same type of oil, which was a highly treated naphthenic base oil, was used in all 62 greases, there was undoubtedly some variation in the viscosity index and pour point. The use of viscosities measured at—65 F would have tended to eliminate the effect of these variations. Also, for the purposes of this correlation, worked penetration is probably not the best measure of consistency.

Conclusions—The above correlation equation is linear. This is probably due to the limited range of variation of the data from which it was derived. It is believed that, if the range of variation had been greater, the equation would have been nonlinear, at least with respect to some of the variables. For the range of conditions encountered, however, the relationship is adequate and shows that apparent viscosity can be affected by each of three independent variables, consistency, soap (or thickener) concentration, and viscosity of the fluid component of the grease.

Under other test conditions, it is probable that some of these variables would have only negligible effect. For example, the effect of consistency, at least as measured by penetration, would probably become negligible at high shear rates, particularly for greases containing very viscous oils. On the other hand, for greases made from very light oils, the effect of viscosity would probably become negligible at low shear rates.

It is expected that in time, with more accurate measurement of apparent viscosity and with continued study, equations will be developed that will permit the prediction of apparent viscosity for a wide range of conditions and for a large number of different types of grease.

Original presentation was before the annual meting of the National Lubricating Grease Institute, San Francisco, October, 1954. The article appeared in *Spokesman*, the society publication.

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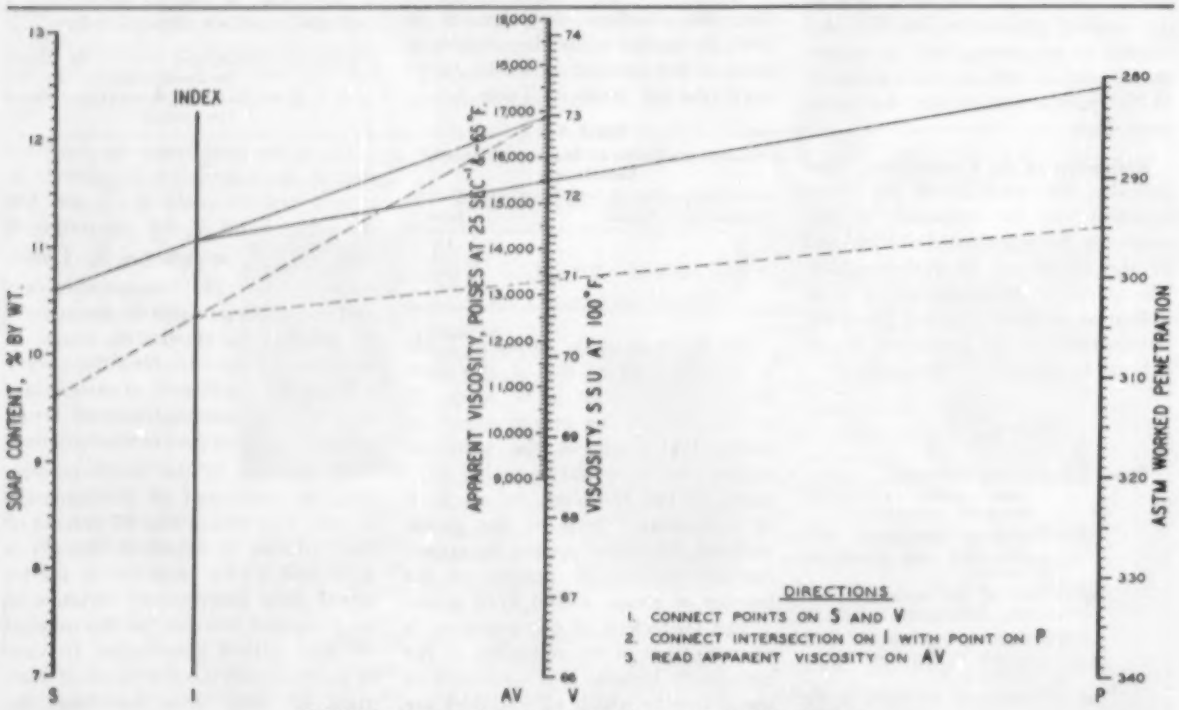
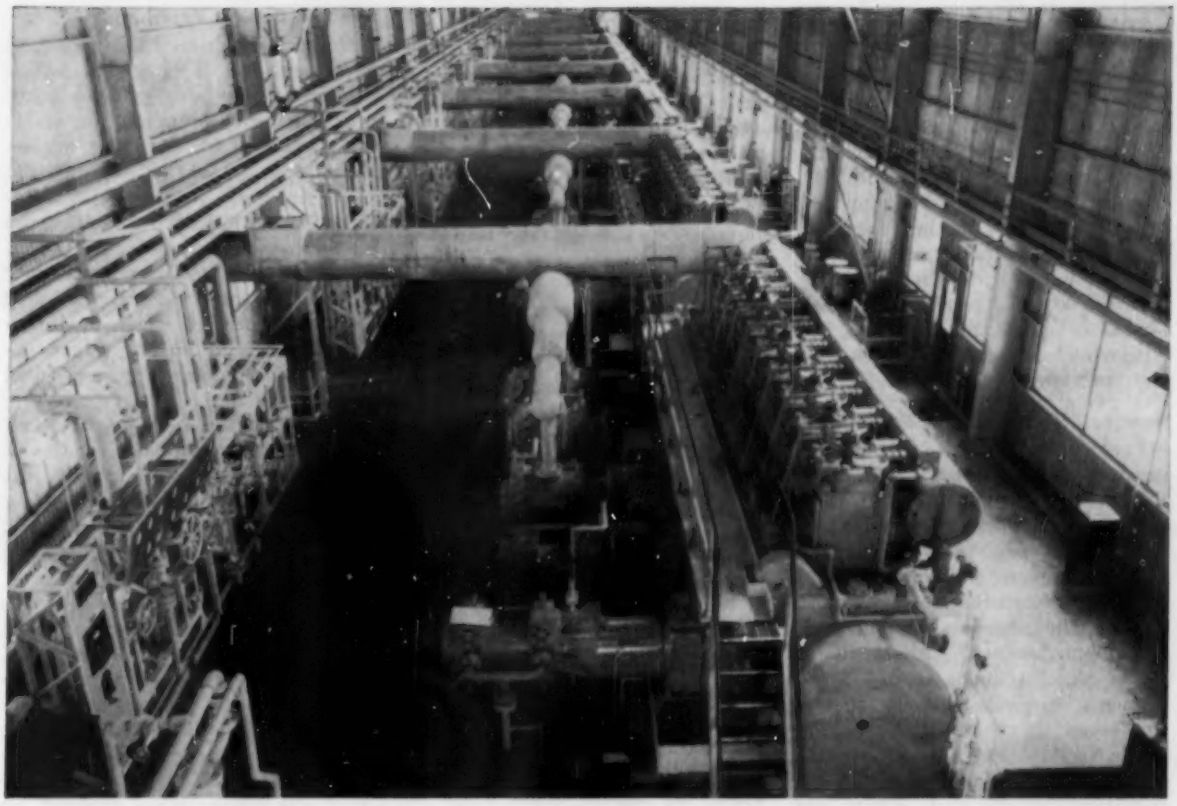


FIGURE 3—Nomograph for calculation of apparent viscosity of grease.



Interior of a compressor building in an ammonia plant

How to Choose Materials of

Construction for Ammonia Synthesis

Ammonia can be made with little trouble if sufficient attention is paid to the fundamentals of attack by hydrogen and nitrogen, sound engineering design, rigid inspection and the specification of high quality materials and equipment.

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Refiner Staff

THE DESTRUCTIVE effects of hydrogen and nitrogen at high temperatures and pressures present some of the most challenging problems materials engineers have ever faced. One cynic said, "Some metals are lousy; others are worse." Everything one can think of including gold and platinum has been tried at one time or another. Actually, the large scale, growing and profitable production of ammonia today demonstrates that even if these problems cannot be completely solved, they can be controlled.

A combination of design and the judicious selection of materials gets the job done. The principles governing these are relatively simple.

The Hydrogen Problem

The first problem to examine is hydrogen. At high temperatures and pressures, hydrogen attacks iron, steel and most low alloy steels causing highly destructive internal micro-fissuring, embrittlement and loss of strength. Although two damage mechanisms are involved, the most important is the reaction between hydrogen and carbon in the steel to form methane. Atomic hydrogen, being merely a proton plus an electron, can diffuse through the steel with great ease.

The carbon is present as iron carbide. When the hydrogen reaches the carbide particles, the methane molecule which is formed cannot diffuse away. The tremendous pressures resulting cause fissuring in the vicinity of the carbide particle. Another form of embrittlement is thought to occur by the diffusion of hydrogen atoms into sub-microscopic defects in the steel, where the atoms unite to form hydrogen molecules which exert a very high pressure within the defect.

How to Lick Hydrogen Problem

For moderate conditions of temperature and pressure the solution to the hydrogen problem is to add strongly carbide-forming alloying elements to the steel. The most important of these is chromium.[3] Vanadium in small amounts has found some use in low alloy steels. Titanium and columbium are used with the chromium nickel stainless steels.[3] These elements have such a strong affinity for carbon, that their carbides remain relatively stable.

As a simple rule of thumb, as the conditions become more severe, use alloys containing more chromium; and finally augment the chromium with titanium or columbium. Thus, we might construct a table as follows:

low carbon steel
1% chromium, 0.5% molybdenum
2% chromium, 0.5% molybdenum
5% chromium, 0.5% molybdenum
18% chromium, 8% nickel type 304
18% chromium, 8% nickel plus titanium, type 321
18% chromium, 8% nickel plus columbium, type 347

Molybdenum is added to all the straight chromium steels for metallurgical reasons, and its presence in this service is probably beneficial. Creep strength, ductility and ease of fabrication indicate a change to the chromium nickel stainless steels when one desires a chromium content over five percent. Nine and 12 percent chromium alloys might be considered for some intermediate conditions, and the 12 percent chromium alloy is used for liner sheets in some layer vessels.

The Nitrogen Problem

Iron and its alloys, including the stainless steels are subject to nitriding. This is damaging, but fortunately it does not constitute as serious a problem as hydrogen attack. The nitride layer at the surface forms a barrier to the further inward diffusion of nitrogen. According to Ihrig, this barrier is most effective in Type 347 stainless.[2]

Copper, nickel and nickel-rich alloys are not subject to nitriding. Strongly deoxidized copper (for example, copper tubing ASTM Spec. B75-52 type DHP) is immune to attack by both hydrogen and nitrogen.[1,3] In fact it is the most resistant material to the conditions of ammonia synthesis yet discovered. This may startle some who are familiar with the rapid attack of ammoniacal solutions on copper and its alloys. The discrepancy is resolved when one recalls that the attack is due to the formation of a copper-ammonia complex ion in aqueous solutions. Unfortunately, the low creep strength of copper limits its use to heat exchange tubing where the pressure is practically equal on both sides of the tube wall.

Tough pitch copper (not deoxidized) contains intergranular oxides. These are rapidly reduced by the hydrogen with disastrous effects on ductility and strength. Thus the older literature contains many statements that copper is unsuited for the conditions of ammonia synthesis.[3]

Nickel and Monel metal are embrittled by intergranular attack. It is reported that Claude process cylinders are made of an alloy containing 60 percent nickel, 12 percent chromium and 2.5 percent tungsten, balance iron and that they have a life of 2000 to 25,000 hours.[1] Available data on other nickel-rich alloys are meager. It is suggested that potential users either secure authoritative information or conduct tests before trying. Several hundred hours in a reactor plus a metallurgical microscope and some ductility tests will separate the men from the boys.

A second article in this series,

"Metals Don't Crystallize . . . . You Can Prevent Fatigue Failures"

will appear in an early issue of Petroleum Refiner

Specific Design Problems

Reactor vessels are made of forged alloy steels or of laminated layers. The latter may have an inner lining of 12 percent chromium-iron stainless Type 410 for insurance against hydrogen attack. Excepting the Claude process cylinders, relative immunity from hydrogen attack on the reactor walls is attained by design. Incoming cold gases sweep the inner wall of the reactor and keep it below a temperature at which hydrogen attack will occur to any serious extent. Brick linings are reportedly used to some extent.

Forged reactor shells, heads, in fact all the high pressure components of any process, i.e., valves, piping etc., should be made of fine grained steels. This aspect is discussed by Busby et al. in the analysis of a failure of a forged vessel at Trail, British Columbia.[4]

Compressors, valves and piping are subject to repeated cycles of stress originating with the piston strokes of the compressors. These stress cycles take the form of pressure surges and vibrations, as well as stresses arising from the reciprocating motion of the compressor and valve components. Such conditions, unless designed for and anticipated, lead to fatigue failures. Precautionary design against such failures includes anchoring piping and installing damping devices which will reduce both pressure surges and the amplitude of vibration in the piping. Welds should be carefully contoured and even slight undercut repaired. In machinery components, deep tool marks and gouges should be avoided. Shoulders in shafting and other changes in section in reciprocating parts should be streamlined if possible, and at the very least they should be provided with the most generous possible fillets.

In conclusion, ammonia can be made with little trouble if attention is paid to the fundamentals of attack by hydrogen and nitrogen, and sound engineering design, rigid inspection and the specification of high quality materials and equipment.

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Hydrogen—Its Markets and Uses

Catalytic reforming units will make available tremendous quantities of hydrogen. Largest use will be in ammonia manufacture, but there are many other possibilities.

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HYDROGEN HAS assumed importance in the refining industry during the past five years as a result of the development and rapid commercialization of catalytic reforming processes. The hydrogen is potentially useful for some chemical processes because its purity is high, ranging from 85 percent up to the high 90's.

The total availability of such hydrogen stands at roughly 1000 tons per day at diverse locations in the United States. This quantity is generated in catalytic reformers totaling about 570,000-bbl.-per-day capacity and can be expected to grow further in the next several years, inasmuch as reforming is used as a partial supplier of high-octane components. By 1956 about 924,000 bbl. of capacity will be operating, which will increase the total hydrogen to 1600 tons per day.

The refining industry itself will likely become a large consumer of hydrogen to desulfurize petroleum stocks and to hydrogenate olefins. One refining company has stated that it may eventually become a net consumer of hydrogen beyond what is now available as a byproduct. Consideration of the potential fuel markets of hydrogen, either in gas or petroleum products, is not within the scope of this discussion. Such uses overshadow the possible volume of hydrogen consumed for chemicals because of the very large total volume of petroleum products and gas compared to chemicals. To give an idea of the relative size of the petroleum and chemical industries, the entire petrochemicals industry — including "near chemicals" such as carbon black — in 1954 accounted for less than 3 percent of the volume of hydrocarbons refined into fuels.

In considering the nonfuel uses for hydrogen, it is useful to classify them into 2 categories, viz.: 1, those uses in which hydrogen is required independently of carbon monoxide; and, 2, those synthesis-gas uses in which carbon monoxide is an accompanying reactant with hydrogen.

It is in the first type of chemical uses that catalytic-reformer hydrogen is potentially more valuable.

Uses for Hydrogen Not Involving Carbon Monoxide

Ammonia Manufacture—Ammonia manufacture is by far the largest outlet for the hydrogen used independently of carbon monoxide, amounting to 1400 to 1500 tons per day. Ammonia—through its direct use as a fertilizer and, more importantly, through its derivatives such as ammonium nitrate, nitrogen solutions for mixed fertilizer manufacture, urea, and ammonium sulfate — has exhibited outstanding growth since World War II. In the fiscal year 1950-51, the total quantity of fixed nitrogen from ammonia produced in the United States was 1,560,000 tons, whereas in 1954-55 the supply had grown to about 2,470,000 tons, or 58 percent in 4 years. The impetus for this growth is primarily in demand for fixed nitrogen used in fertilizer. We expect this demand to continue to expand rapidly but, if the plant capacity to produce ammonia — the primary raw material for making useful nitrogenous fertilizer materials —continues to increase at the rapid rate of the past three years, substantial oversupply with its attendant adverse economic effects is likely.

New ammonia plants for the next several years cannot be predicated on the need for additional nitrogen. Instead, most new ammonia projects not involving captive consumption must be justified on process cost advantages, cheaper raw materials, freight savings resulting from location, or other relative economic advantages which prospective new producers may offer.

Published information indicates that ammonia plants based on catalytic-reformer hydrogen are cheaper to build than those based on natural gas, fuel oil, or coke, because the hydrogen-producing section of the conventional ammonia plant is eliminated. Further substantial advantages are available because unlike other ammonia processes, the hydrogen is delivered at high pressure—200 to 700 psi—and savings occur in compressor investment and in compression energy, both important contributors to the cost of ammonia manufacture.

The operation of new ammonia plants based on reformer hydrogen, however, is not without its economic difficulties. The sale of nitrogen products to fertilizer outlets, which account for about 70 percent of all nitrogen consumed, is a highly seasonal operation. Many fertilizer manufacturers sell the bulk of their products in a two- to three-month period. In many instances fertilizer manufacturers accept delivery of nitrogen materials only eight months of the year, and rarely is it possible in a competitive market to find a fertilizer manufacturer who will accept equal monthly deliveries. Such customer purchasing habits require extensive, and incidentally expensive, storage capacity for the nitrogen products. Furthermore, in the competitive fixed-nitrogen market which is developing, and to some extent which is with us today, it will be necessary to convert much of the ammonia to the specific derivatives which consumers demand.

In the case of urea the ammonia plants based on catalytic-reformer hydrogen are at some disadvantage to plants based on natural gas, inasmuch as no carbon dioxide, needed for urea synthesis, is produced simultaneously with the hydrogen. Carbon dioxide can be obtained from flue gas, but such sources do not give the purity obtainable from shift reactors in conventional ammonia plants. Urea, containing 45 percent fixed ni-

trogen, is likely to become more popular, particularly in the Middle West where the nitrogen consumption is increasing most rapidly percentagewise and is expected to become a major-volume ammonia derivative during the next 10 years.

The combined industrial and military markets for nitrogen constitute 30 percent of the total market. These markets are not nearly so seasonal as fertilizer and are highly desirable; consequently, they are competed for vigorously, particularly because most of the demand is in the form of ammonia. New producers of ammonia cannot count on more than a normal share of this desirable market because of its attraction to others.

The following four points should be considered by potential new noncaptive producers of ammonia:

1. Capacity to produce ammonia is greater than demand, and some replacement of markets served by others should be counted on.

2. Generally, it will be necessary to sell most of the material to the fertilizer industry, which is traditionally operated on a seasonal basis.

3. Derivatives of ammonia will be required to serve the fertilizer trade. Many farmers are neither equipped for, nor desirous of, using ammonia directly.

4. Marketing strength will be an outstanding requirement for success in the production of ammonia and its derivatives.

Fat Hydrogenation—The addition of hydrogen to fatty oils—particularly edible oils such as cottonseed and soybean oils used for margarine and shortenings—although accounting for less than 1 percent of the weight of the oil, is a reasonably important outlet for hydrogen. This use is perhaps second in importance to ammonia, although a poor second. The purposes of such hydrogenation are to eliminate the poly-unsaturated acids such as linolcic and oleic in order to avoid oxidation, and to convert the liquid oils to solids. Fat hydrogenation is usually carried out in batch reactors in the presence of nickel catalysts at pressures below 100 psi. The hydrogen must be of high purity, particularly with respect to elimination of sulfur and carbon monoxide, in order not to poison the catalyst.

Organic Chemicals—In the manufacture of organic chemicals there are numerous examples in which hydrogen used independently of carbon monoxide is required to the extent of 1 to 5 percent of the weight of the chemical product, but few single outlets are large, and markets for catalytic hydrogen are not likely to become general. Instead, they will probably depend more on fortuitous location of catalytic reformers near those chemical plants using hydrogen for several purposes. Perhaps the most important example of chemical hydrogenation is in the aldol process to produce alcohols having chains of four to eight carbons. However, the importance of aldol processes is decreasing in favor of Oxo processes which utilize less hydrogen. Also, the hydrogen which is utilized in Oxo processes is in the form of synthesis gas containing carbon monoxide, thereby placing this outlet in the second type of use category. Other organic chemicals being hydrogenated are glycolic acid to make ethylene glycol, and adiponitrile to hexamethylenediamine; but such outlets are not important volumewise.

Metallurgy—One potential market for hydrogen is in metallurgy, particularly as a reducing agent in the manufacture of metal powders, but also in the manufacture of metal hydrides. During 1954 iron powders used primarily for making small metal articles such as bearings, magnetic tape, welding rod, gears, and the like, almost doubled in volume to a total of 25,000 tons, equivalent to a hydrogen market of 1300 tons. The nonferrous powder metals market was of the same order of magnitude. Substantial growth is expected in powder metallurgy, and refineries located near such operations may find some desirable markets.

Uses for Hydrogen Involving Carbon Monoxide

In the second type of chemical use for hydrogen—i.e., in uses in which it is associated with carbon monoxide—hydrogen from catalytic reformers is at a decided disadvantage to the hydrogen made either by the partial oxidation of natural gas or by the water-gas reaction employing steam with either coke, coal, or natural gas. Processes using hydrogen in conjunction with carbon monoxide include methanol manufacture, the Oxo process, the modified Fischer Tropsch process exemplified by the Brownsville operation, and the Oxyl process which has not attained commercialization. The hydrogen used for methanol is the largest such outlet, amounting to about 200 tons per day to correspond to 1.1 billion pounds of methanol produced per year.

Excluding the possible economic generation of supplies of carbon monoxide independently of hydrogen, however, reformer hydrogen can probably enter into such operations only as a supplemental reactant. In some processes utilizing synthesis gas it is desirable to adjust the hydrogen–to–carbon-monoxide ratio to higher levels than the 2:1 ratio involving partial oxidation of methane, or the 3:1 ratio involving methane and steam. Traditionally such ratios are obtained through shifting part of the carbon monoxide to carbon dioxide by reaction with additional steam, thereby sacrificing a portion of the carbon monoxide. Reformer hydrogen could be used as a supplement to avoid shifting of the carbon monoxide.

Development of New Uses

Considerable development is needed if chemical outlets for the increasingly large volume generated in catalytic reformers is to be assured in markets other than ammonia. New outlets are needed, which require hydrogen volumes of the same order of magnitude as that now consumed in ammonia. Research could perhaps be expanded on reactions analogous to ammonia, and the development of phosphine to commercial quantities may be such an example. Phosphine offers a potential way of shipping phosphorus at a highly concentrated level, and perhaps such developments could aid the exploitation of elemental phosphorus by reducing the effective freight cost of shipping this fertilizer material from its origin to its point of consumption. The possible commercialization of coal-hydrogenation processes for chemicals now in the development stages is another example.

In reactions of hydrogen involving synthesis gas, the research opportunities encouraging reformer-hydrogen consumption are reduced largely to economic developments of carbon-monoxide sources which exclude simultaneous production of hydrogen.

Original presentation was before the API Division of Refining midyear meeting, St. Louis, May, 1955. ##

Electrical System Modernized

In modernizing a refinery electrical system, four salient factors to be considered are: (1) distribution voltage and power source, (2) dependability and continuity, (3) system flexibility, and (4) operational simplicity.

W. H. East and G. R. Dunbar*

AS A REFINERY grows in size and complexity, the electrical system must be expanded to keep pace. At the same time, consideration must be given to modernizing the existing system to provide a dependable, flexible system for the entire plant. Modernization of the electrical system was recently completed at Tide Water Associated Oil Company's Avon Refinery, which is a 95,000-barrels-per-day refinery located in Contra Costa County on San Francisco Bay.

Background of Electrical Distribution—The original electrical distribution at the Avon Refinery was at 2400 volts and this distribution is still used today. The existing substation No. 1 was constructed in 1929 and consisted of 22 feeders using oil breakers of fixed position design with disconnecting switches for isolation from the 2400-volt bus. At the outset, this substation fed the plant and its limited confines adequately. However, as the plant expanded to meet the demand for newer petroleum products, it became necessary to increase the number of feeders as well as extend the length of distribution lines.

In the middle 30's it became necessary to add Substation 2. This consisted of an open-type outdoor substation with fixed position oil circuit breakers, single bus system with 10 feeders. The rapid expansion of refinery facilities before and during the war soon made it necessary to add Substation 3. This substation consisted of modern drawout type oil circuit breakers, of indoor metal clad switchgear construction which fits in with the present day thinking of the modernization of the electrical distribution system. Substation 2 has been recently modernized to the extent of double bus arrangement, additional drawout type oil circuit breakers with overload protection and the replacement of dash pot series tripping devices with overcurrent relays. Eventually, Substation 1 will be replaced to fit in with the modernization trend.

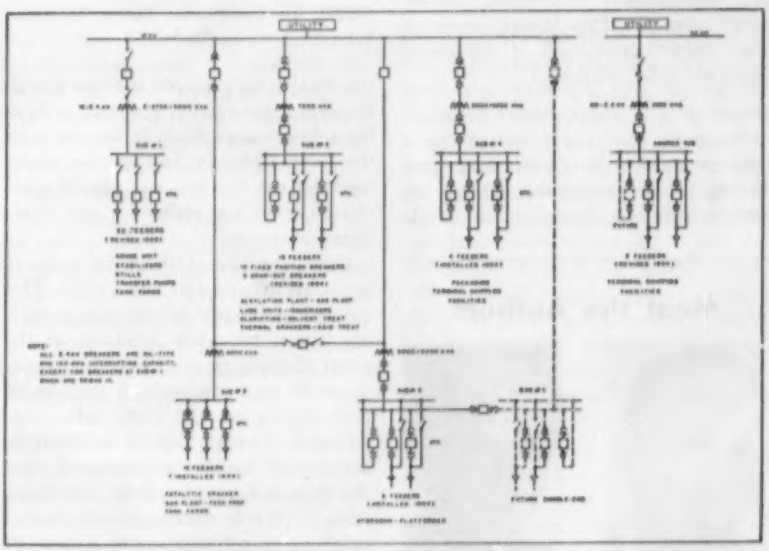

FIGURE 1—Simplified diagram of the refinery distrubution system.

The two most recent substations are 4 and 5, employing the double bus transfer switch arrangement which forms the heart of dependability and continuity of service. These substations are equipped with transformers throat connected to their respective switchgear, forming unit substation type designs.

The Avon Refinery does not generate any of its power. Power is purchased from the electric utility company which generates power at a steam plant immediately adjacent to the Tide Water property. This steam plant radiates 12-kv feeders to local distribution centers throughout the refinery. The utility is responsible for dependable 2400-volt service to the refinery's distribution switchgear. See Figure 1.

Electrical Distribution Requirements—The general electrical distribution requirements of a refinery are similar to those encountered in other industrial process plants of comparable size. The basic needs of system dependability, continuity, and flexibility as well as simplicity are imperative in refinery distribution. In fact, the

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factor of system dependability and continuity is of the greatest importance in petroleum processing because of the continuous nature of the operation. A single day of unplanned shutdown of refinery operation represents considerable loss in dollars, frequently sufficient to justify the initial cost of more expensive and elaborate distribution equipment.

As a matter of background, the four salient factors which must be considered in refinery electrical distribution are: (a) Distribution voltage and power source, (b) Dependability and continuity, (c) System flexibility, and (d) Operational symplicity. Before considering the Tide Water system, a brief discussion of each of the above factors will be presented.

Distribution Voltage, Power Source

Normally the power source for a refinery consists of one or more generating plants supplemented by an electric utility tie. However, frequently the total power source is from a utility with a generating plant at or near the refinery area. Such is the case with the Avon Refinery. In this case, steam used for the turbines can also be purchased from the utility for use in refinery processes.

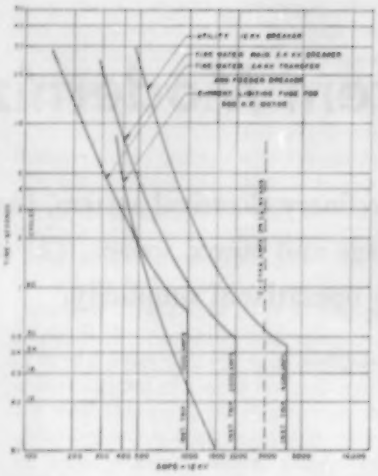

FIGURE 2 — Coordination Curves, Substation No. 4.

Characteristic of the older refinery is the distribution at 2400 volts. This voltage has many advantages providing it can be made available at the point of application without undue expense in transmission and the risk of poor regulation. At 2400 volts, considerable savings can be realized in the cost of motors and control since this is a utilization voltage for them. Also, 2400-volt distribution represents only one transformation to either 480 or 208 volts, whichever is more preferable for utilization purposes.

In any event, the choice of the distribution voltage can appreciably affect the arrangement of the distribution system and equipment. Since the voltage level influences the cost of the apparatus appreciably, careful consideration should be given to the switchgear involved. Generally, the economical use of circuit breakers at 2400 volts is limited to interrupting duties not exceeding 183,000 kva and at 4160 volts to 250,000 kva and below.[1]

For area loads in excess of 10,000 kva, the cost of 2400-volt distribution switchgear may become excessive, and 15 kv becomes justifiable. Likewise, costs for a 15-kv feeder circuit are lower than those for 2400 volts, due mainly to the lower current requirements and the greater permissible circuit loading within voltage regulation limits. However, the particular area load requirements, i.e. size and number of motors and distance from the point of distribution must be considered in each case.

Dependability and Continuity

When considering the factors of dependability and continuity, consideration must be given equally to the equipment arrangement and the type of system. The use of double-bus schemes has gained considerable prominence in distribution equipment to provide a greater degree of service continuity. All double-bus schemes permit a circuit to be transferred to another feed while the original feeder is removed from service for inspection or maintenance. The type of transfer and method used may vary with the double-bus scheme employed, however, the basic principle of feeder transfer is evident.

The general use of metal clad switchgear provides the requisite of dependability more adequately than other forms of equipment. Whether the metal clad gear is placed indoors or whether it is weather-proofed for outdoor use does not reduce its dependability. The availability of indoor space versus the additional cost of outdoor equipment usually determines which type of equipment is used. Drawout circuit breakers, insulated bus, efficient circuit interruption, and automatic restoration are but a few features available in metal clad switch gear which promote dependability and continuity. In corrosive or hazardous atmospheres, oil circuit breakers receive general recognition. However, where the atmosphere does not dictate oil immersed contacts, air circuit breakers are readily used and the oil handling problem is eliminated.

See "Electrical Power Distribution for Industrial Plants."[2]

System Flexibility

It is frequently necessary to move loads, increase the capacity of certain loads, or to add feeders for new loads in a refinery to meet changing processes or production methods. The ability of an electrical distribution system to accommodate these changing load requirements with the minimum of distrubance and interruption to electrical facilities is considered system flexibility. System flexibility is particularly necessary in today's refinery processing with the steadily growing need for additional output and changing methods.

Meet the Authors

East

Dunbar

WILLIAM H. EAST, assistant general foreman at the Tide Water Associated Oil Company refinery in Associated, Calif., met his co-author while they were planning a modernization of the distributive system at the Avon plant. An electrical engineering graduate from the University of California, he has been with Tide Water for the past seven years.

GEORGE R. DUNBAR, who is consulting and application engineer with Westinghouse Electric Corporation in San Francisco, has been working with Tide Water engineers for the past two years. He holds, in addition to an electrical engineering degree from the University of California, a master's in business administration from the University of Pittsburgh.

FIGURE 3a—Substation No. 1 (Front View).

FIGURE 3b—Substation No. 1 (Rear View).

To provide for future capacity increases, the transformer size at the primary substation should be studiously selected. If the estimated loading condition is such that a standard transformer self-cooled kva rating will render sufficient capacity, based on growth potentialities, this rating is the economical choice. If, however, the transformer capacity appears to be too close to the estimated load and projected growth, consideration should be given to making provision for increased capacity by adding fan cooling in the future or equip the transformer with fans at present. Increasing transformer capacity with fans usually results in a higher cost per kva on the fan-cooled basis with losses increasing in greater proportion than the increased kva. For this reason, if it is planned to ultimately run the transformer continuously at the fan-cooled rating, consideration should be given to the next higher self-cooled kva rating.

The ideal arrangement to provide for load growth in the primary distribution switchgear is to permit addition of future feeders without disturbing the existing ones. One way to include this feature is to provide a tie breaker in the initial equipment with provisions for double-end feeding. When ultimate double-ending is provided, operation with the bus tie breaker open is recommended to prevent doubling the availabie capacity to each feeder with the possibility of applying it beyond its interrupting duty. There are times when spare feeders are supplied at the initial installation. Such units can be connected without de-energization of the distribution bus by keeping the feeder breaker open until the load is connected. All other means of adding circuit feeders to the primary equipment make it necessary to shutdown temporarily to make connections.

Since flexibility is an over-all system problem, all equipment to be affected by additional capacity should be applied on the basis of the ultimate power conditions. The most elaborate system planning for additional feeder circuits is useless if the existing equipment is not of adequate size to handle the increased capacity.

Operational Simplicity

The factors of system continuity and flexibility are put into effect efficiently by simple, direct-acting equipment. The need for operational simplicity becomes most apparent during times of emergency power outage where each minute of process shutdown represents loss in dollars.

If a double-bus scheme is employed, which is becoming more common practice in refineries, the procedure of feeder transfer should be well established with operating personnel to keep down time to a minimum. In any event, the equipment operation should be safe, simple and direct-acting, with interlocking where necessary to insure proper and foolproof operation.

Tide Water Electrical System

In the planning phase of the modernization and expansion of the refinery electrical system, the existing system was examined to determine its weaknesses from operational, maintenance and safety standpoints. From past experience, it was readily apparent that the interrupting ratings of future equipment should be higher to meet the increased capacity of the utility to feed a fault; that alternate feeder breakers should be provided to keep processing units in operation; that provisions should be made to facilitate maintenance of electrical equipment without having to wait for shutdowns of units; that more reliable and accurate relaying should be provided to prevent unnecessary power failures; and, that the electrical equipment should be so constructed as to provide maximum safety to operating personnel.

By the use of current limiting reactors on all 12-kv feeders radiating to the refinery and maintaining sufficient impedance in substation transformers, the utility has limited the interrupting requirements to 100,000 kva at 2.4 kv. In order to provide for maximum interchangeability it was decided to standardize on 100,000-kva interrupting rating circuit breakers for all 2.4-kv switchgear.

Reliability of relaying became a factor when the company began to replace large steam pumps with electrical motors in the 700-hp range. The old ITL and dash pot type relays were so unpredictable that it became necessary to have an electrician standby in the substation each time one of the large motors was started in order to put the circuit back on the line in the event of trip-out. Of course the process superintendents shortly began to demand a solution to the problem to prevent costly disruptions to production. Overcurrent relays were adapted to one circuit breaker in Substation 1 with excellent results. Sub-

sequently most of the circuits in that substation have been so equipped and outages due to high inrush current on start up of large motors has been eliminated.

The equipment as installed at Substations 1, 2 and 3 did not permit the removal of a circuit breaker for maintenance purposes without disturbing service. In fact, Substation 1, constructed 25 years ago, is indoor equipment consisting of open type construction with bare busses, as shown in Figure 3. Therefore, it was impossible to provide for regularly scheduled preventive maintenance. Maintenance could be effected only in the event of service failure or at irregular intervals when units were shut down for repairs. The maximum permissible shutdown time for electrical circuits is normally eight hours, hardly enough to do a thorough job. To illustrate the point at hand, Substation 3 was in operation for nine years before the entire units could be shutdown for a one day overhaul.

At Tide Water, safe working conditions for the employes are considered to be of prime importance, and vast sums are spent to provide such conditions. In selecting new electrical equipment, much emphasis is placed on personnel safety. All live parts must be completely enclosed, and interlocks must be provided to prevent improper sequence of operation. Although the substations are located in non-hazardous areas, it is preferred that the breakers operate under oil because of a corrosive atmosphere. The transfer and feeder circuit breakers in substations 3, 4 and 5 are identical electrically and physically which adds to the effectiveness of service continuity and dependability as well as the economical aspect of complete inter-changeability.

In order to eliminate the cost of construction of expensive buildings to house the breakers and to conserve on indoor space, the equipment is metal clad in weather-proof enclosures.

The unit-type substation proved to be the answer to the above requirements. See Figure 4. A main and transfer bus arrangement, as indicated in the single-line diagram for Substations 4 and 5, make it possible to maintain feeder power during transfer for maintenance and inspection of

FIGURE 4—Substation No. 4 showing 5000-kva unit.

feeder breakers. The procedure here is to close the transfer bus disconnect switch for the feeder breaker to be removed from service, close the transfer breaker, and then trip the feeder breaker and remove it to the inspection rack. Each transfer bus disconnect is interlocked with the transfer breaker so that the disconnect cannot be opened or closed unless the transfer breaker is in the open position. Although these disconnects are externally operated, the additional safety factor of interlocks was introduced to prevent the possibility of opening the disconnects under load. All live parts are completely enclosed, including the primary connections at the transformer. The secondary connections from the transformer to the switchgear are likewise enclosed in a throat connection, thus providing for maximum safety for operating personnel. These safety measures remove any necessity for a fence around the substation.

Overcurrent relays provide for reliable quick-acting and selective tripping. Each set of feeder breaker relays is coordinated as well as possible with the current limiting fuse motor starters being fed by the breakers. Although complete coordination is not obtained between overcurrent relays and fuses on the larger motors, operating experience has been satisfactory. This coordination extends completely from the utility breaker relays down through the load breakers. A typical relay curve is shown in Figure 2.

A combination of overhead and ground distribution lines is used for distributing power throughout the Avon Refinery. Normally, for shorter lines, one-fifth of a mile or less, underground varnished fabric lead-covered cables are used. It is generally preferred to keep distribution cables underground to minimize obstruction to maintenance equipment such as cranes, and because of corrosive atmosphere present in refinery areas. However, due to the greater cost of underground distribution, overhead construction is used on longer lines.

There is no general plan in the near future to tie the 2.4-kv distribution lines together. It is felt that this added security is not justified since the double-bus type distribution system provides sufficient reliability, obviating a secondary loop.

SUMMARY

The modernization of the electrical distribution system of the Avon Refinery has incorporated the following features:

1. Reliable overcurrent relaying protection replacing former less accurate ITL and dash pot tripping devices.

2. All modern distribution equipment to employ double-bus type construction replacing single-bus distribution formerly used. This type construction permits greater flexibility and regular maintenance of feeder circuit breakers without discontinuation of service.

3. Metal clad switchgear with oil circuit breakers rendering greater protection to circuit breaker contacts from corrosive refinery atmospheres.

4. All unit substation type design employing bus connection between transformer and switchgear providing maximum reliability and over-all coordination.

5. All equipment provided in weather-proof enclosure for outdoor construction, minimizing usage of valuable indoor space.

6. Standardization on all circuit breaker ratings, electrical and physical interchangeability, providing greater continuity of service, economy, and ease of maintenance.

Original presentation was at the Winter General meeting of the American Institute of Electrical Engineers, New York, February, 1955.

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[2] "Electrical Power Distribution for Electrical Plants," AIEE publication, PP 17-30 and PP 50-61.

[3] "Modern Electric Distribution System for an Oil Refinery," V. L. Nealy. Elec. Eng., November, 1953. PP 1008-1011.

[4] Electrical Transmission and Distribution Reference Book, Westinghouse Electric Corporation, Chap. 20.

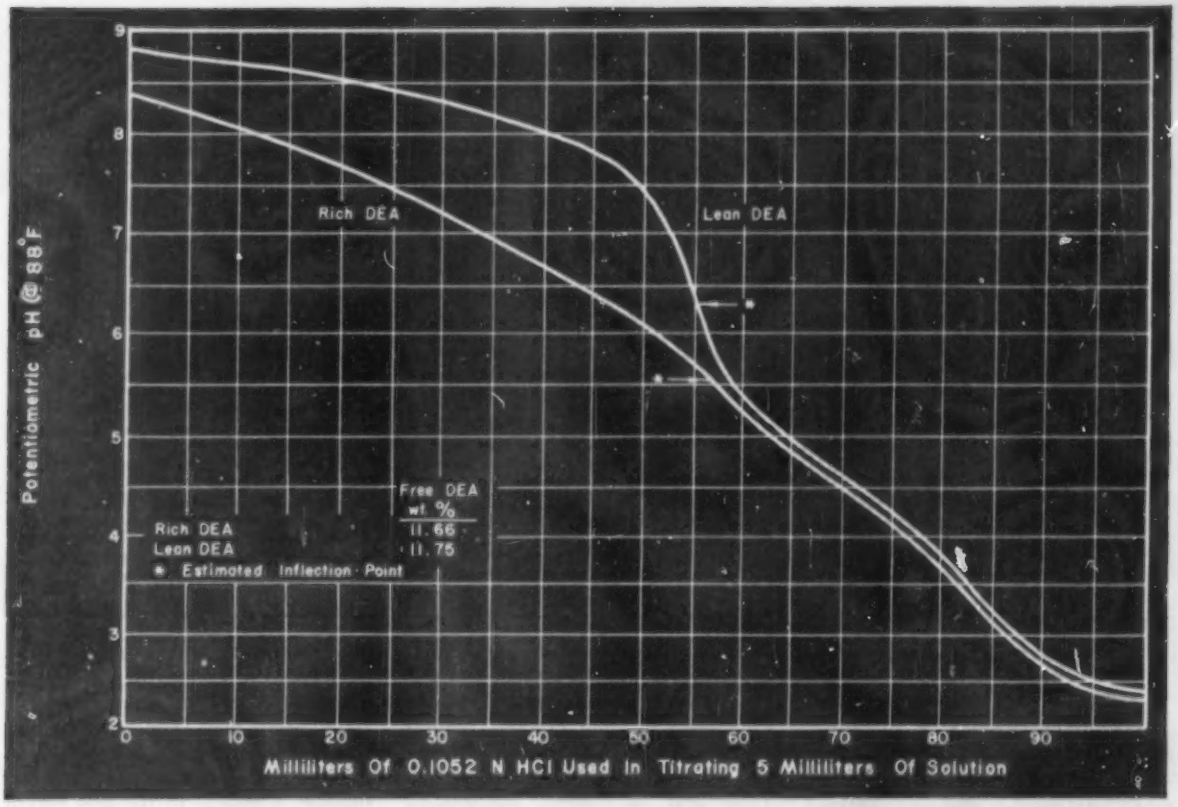
Potentiometric pH @ 88°F
Rich DEA
Lean DEA
Free DEA wt %
Rich DEA 11.66
Lean DEA 11.75
* Estimated Inflection Point
Milliliters Of 0.1052 N HCl Used In Titrating 5 Milliliters Of Solution

FIGURE 1—How plant rich and lean DEA streams compare on potentiometric titration curves.

How to Analyze DEA Solutions

Watch the acidic constituents since they tie up diethanolamine solution from doing its job of removing hydrogen sulfide.

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General Petroleum Corporation

IN ORDER TO maintain checks on the condition of the diethanolamine and on the amount of hydrogen sulfide removed from the refinery streams at General Petroleum's plant at Torrance, Calif., daily control tests are made on both the rich and lean solutions. The hydrogen sulfide content is determined by iodimetric titration, and the diethanolamine available for hydrogen sulfide absorption (usually called "free" DEA) is determined in the l an solution by titration with standard acid to the inflection point on a potentiometric curve.

Investigation of Stable Diethanolamine Salts—Since an aqueous solution of diethanolamine gives a basic reaction, it will react to some extent with all acidic substances. For this reason, it is to be expected that, in addition to hydrogen sulfide, any odor and acidity of the distillate will will also tend to be extracted in the absorption system. If these materials are more strongly acidic in aqueous solution than hydrosulfuric acid, they will form heat-stable salts with diethanolamine from which the latter will not be liberated during the regeneration process.

Although acidic constituents forming stable DEA compounds may be present in the refinery gas in very small concentration relative to the hydrogen sulfide, in a closed system their salts will continue to accumulate in the absorption fluid. This will

result in a gradual diminishing of the available diethanolamine until, in time, its replenishment becomes necessary in order to maintain efficient absorption of hydrogen sulfide.

Among the acidic materials which our laboratory has investigated as possible constituents of the refinery DEA solutions, and those for which analyses are usually made during periodic examinations are: (A) organic acids, (B) chloride, (C) cyanide and thiocyanate, and (D) sulfite, sulfate, and thiosulfate.

A. *Organic acids*—In order to detect organic acids in a used diethanolamine solution containing an accumulation of stable salts, distillation from phosphoric acid may be used. The odor and acidity of the distillate will indicate the presence of organic acids. Norris and Clegg[2] showed that the organic acids extracted by diethanolamine from cracked refinery gases consisted principally of acetic and formic acids. Their work indicates that, in general, the organic acidic constituents of refinery gases are low-molecular-weight, monobasic acids having dissociation constants greater than the first dissociation constant of hydrosulfuric acid.

For practical purposes, it is not necessary to identify the individual organic acids in routine analyses of the absorption fluid, since their diethanolamine equivalent can be determined by potentiometric titration with standard acid. This was noted when the potentiometric titration curves of lean DEA solutions showed two inflection points. The second inflection point, occurring approximately at a pH of 3.5, was not found in the titration curve of unused diethanolamine, but became more pronounced in the plant solution as stable salts accumulated. Typical titration curves for rich and lean solutions from the DEA system after it had been in operation for some time are shown in Figure 1.

A titration curve showing inflection points similar to those of the plant solution was obtained on a synthetic solution of unused diethanolamine containing acetic acid and other stable salts known to be present in the regenerated DEA. The difference between the first and second inflection points in the titration curve was found to be a good measure of the added acetic acid. The curve for this titration is represented by Curve B in Figure 2. Moreover, another synthetic solution, identical to the first except that it did not contain acetic acid, gave a titration curve resembling that of the pure DEA as shown in Curve A of Figure 2. It will be noted that this curve has only one inflection point.

The first inflection point in the potentiometric titration of plant DEA solutions is a measure of the uncombined diethanolamine. In pure DEA solutions, this value has been found to agree with that obtained by titration to the methyl red end point, which is ordinarily used in control tests to measure free diethanolamine. However, it was observed that with plant DEA solutions, the difference between these values increased as the organic acids accumulated. In order to determine which end point gave the more accurate measure of uncombined diethanolamine, solutions containing known amounts of DEA and acetic acid were titrated. It was found that high values for the free amine were obtained by titrating to the methyl red end point, whereas values obtained by titrating to the potentiometric end point agreed with the theoretical amount of uncombined diethanolamine in the solutions. Curves for the titrations are shown in Figure 3. These clearly illustrate the

Where the DEA Stream Comes From

When air pollution became a factor of such great importance several years ago, General Petroleum Corporation built a diethanolamine treater at its Torrance, Calif., refinery. The plant was designed to treat refinery gases and, in addition, a light liquid stream consisting principally of C_3 and C_4 hydrocarbons, from which charge stocks for alkylation and catalytic polymerization units are prepared.

Gases to be treated are collected from various units in the refinery, including those engaged in primary distillation, vis-breaking, thermal and catalytic cracking, alkylation, and coking. Extraction of hydrogen sulfide is accomplished by contacting the gas stream with an aqueous solution of diethanolamine in absorption columns, in a process similar to that described by Bottoms.[3] The principal reactions occurring in the system may be represented by the following equations:

$$(1)\quad (HOC_2H_4)_2NH + H_2O \rightarrow (HOC_2H_4)_2NH_2OH$$

$$(2)\quad (HOC_2H_4)_2NH_2OH + H_2S \underset{\text{hot}}{\overset{\text{cold}}{\rightleftarrows}} (HOC_2H_4)_2NH_2HS + H_2O$$

The hydrogen sulfide enriched DEA (also commonly referred to as the "rich" or "foul" solution) is pumped through more than seven miles of pipe line to Hancock Chemical Company where it is regenerated by heating in a stripping tower. The liberated hydrogen sulfide is further processed to reclaim the sulfur, while the regenerated (or "lean") solution is returned to the absorbers at the refinery. Thus, a continuously-operating, closed system is maintained in which the absorption fluid is enriched and stripped repeatedly in an 11-hour cycle.

Meet the Authors

MELVIN S. HENRY is senior chemist in General Petroleum Corporation's Laboratory department. He was graduated from U. C. L. A. in 1935 with a chemistry degree and returned to the university in 1944 to complete his master's degree. Associated with Tide Water Associated Oil Company, between sojourns at the California university, Henry joined General Petroleum in 1944 as a chemist in the Analytical division.

MICHAEL GRENNERT, a chemist in the same department with Henry, became associated with General Petroleum Corporation in 1945, following various assignments as a teacher. A chemistry graduate from Oberlin College, he received a master's degree from Western Reserve University in 1940. He and Henry are ACS members.

wide range through which color changes occur in the indicator when organic acids are present in the DEA.

B. *Chloride*—Crude oils often contain small amounts of inorganic chlorides, especially those of calcium, magnesium, and sodium. In the refining processes these salts tend to hydrolyze, thereby leading to the formation of hydrogen chloride. In order to reduce the amount of hydrogen chloride that would be liberated by this means, crude oils are frequently pre-washed to remove inorganic salts. However, at General Petroleum's refinery, which processes unwashed crude oils of low salt content, the chloride content of the absorption fluid from the hydrogen sulfide removal system has been negligible. Chloride has been determined gravimetrically in regenerated DEA solutions by precipitation of silver chloride.

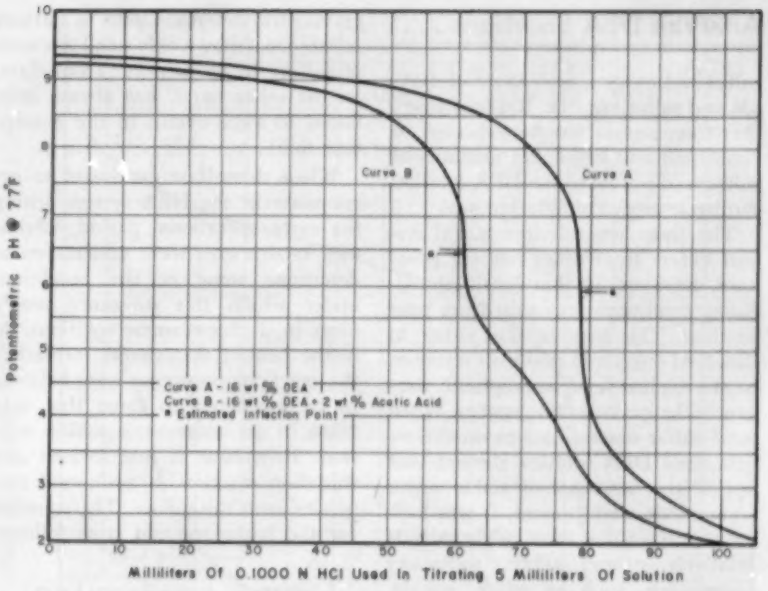
Potentiometric pH @ 77°F
Curve B
Curve A
Curve A - 16 wt % DEA
Curve B - 16 wt % DEA + 2 wt % Acetic Acid
* Estimated Inflection Point
Milliliters Of 0.1000 N HCl Used In Titrating 5 Milliliters Of Solution

FIGURE 2—How synthetic rich and lean DEA solutions compare on potentiometric titration curves.

C. *Cyanide and Thiocyanate*—
During cracking processes a portion of the organic nitrogen compounds, which are present in small amounts in most crudes, is converted to smaller, gaseous molecules such as hydrogen cyanide. Analyses of refinery gases have shown this substance to be present in trace quantities. Although the weakly acidic hydrogen cyanide reacts with diethanolamine, this should not affect the absorptive capacity of the amine solution for the more acidic hydrogen sulfide, as was pointed out by Bottoms[3] in discussing the interferences encountered in ethanolamine absorption systems.

It has been found, however, that under certain conditions cyanide reacts with constituents of a hydrogen sulfide-enriched DEA solution to form thiocyanate, which reduces the available amine content of the solution by stable, chemical combination. The reactions leading to the formation of thiocyanate are believed to be analogous to those that are known to occur in an ammonium sulfide solution to which cyanide is added. Firstly, ammonium sulfide is partially oxidized by atmospheric or dissolved oxygen to liberate elemental sulfur, which dissolves in the ammonium sulfide forming polysulfides. Polysulfides then react with the cyanide in the solution to form thiocyanate as represented by the equation:

$$(3)\quad (NH_4)_2S_2 + 2CN^- \rightarrow 2NH_4SCN$$

The analogous reaction between DEA and cyanide would then be:

$$(4)\quad [(HOC_2H_4)_2NH_2]_2S_2 + 2CN^- \rightarrow 2[(HOC_2H_4)_2NH_2]SCN$$

In order to determine some of the conditions influencing thiocyanate formation in a hydrogen sulfide absorption fluid, laboratory tests were made. To diethanolamine solutions containing small concentrations of cyanide, hydrogen sulfide was added in varying amounts. The mol ratio of hydrogen sulfide to diethanolamine in these solutions was in the range of one-half to slightly over one. In addition, sodium polysulfide was added to portions of the solutions. After the solutions were allowed to stand for various periods of time at room temperature, their thiocyanate content was determined and the following results were noted:

1. In solutions to which polysulfide was added, conversion of cyanide to thiocyanate occurred almost immediately.

2. In solutions to which no polysulfide was added, the rate of conversion of cyanide to thiocyanate decreased with decreasing sulfide concentrations.

3. In general, the cyanide concentration was decreased by one-half within ten minutes and was almost entirely converted to thiocyanate within three hours.

It becomes apparent, therefore, that cyanide tends to be converted to thiocyanate very readily under most plant operating conditions. This conversion of cyanide to thiocyanate in the presence of polysulfide is used in the analytical method for the determination of cyanide in plant DEA solutions. Thiocyanate is first determined on a portion of the sample either gravimetrically, by precipitating it as cuprous thiocyanate, or colorimetrically, by forming ferric thiocyanate. Another portion of the sample is treated with an excess of sodium polysulfide solution in order to convert any cyanide present to thiocyanate, and the thiocyanate is again determined. The difference in the two determinations is a measure of the cyanide content of the solution. It should be stated that the cyanide concentration of plant solutions has been less than the detectable limit of this method, indicating that complete conversion to thiocyanate has occurred within the system.

D. *Sulfite, Sulfate, and Thiosulfate*—Since most petroleum refining processes are conducted in virtually air-free systems, reducing conditions generally prevail. For this reason, the gases formed in such units do not ordinarily contain compounds of both

sulfur and oxygen, such as sulfur dioxide and sulfur trioxide. Refinery gases, therefore, would not be expected to contribute any significant amounts of sulfite and sulfate to the DEA solution during hydrogen sulfide removal.

The hydrogen sulfide removal system differs from other refinery processes, however, in that localized oxidizing conditions may exist from time to time. This may be due either to dissolved oxygen in make-up water or to the inclusion of atmospheric oxygen in the gas collecting system. When total sulfur determinations on the regenerated DEA solution showed that appreciable amounts of stable sulfur compounds were present, it was logical to suspect that these might include relatively strong, acidic, sulfur-oxy compounds, such as sulfite, sulfate, and thiosulfate. In repeated analyses of regenerated DEA solutions by the method of Uhrig and Levin,[4] however, we have found no sulfite; and gravimetric determinations as barium sulfate have shown only small amounts of sulfate to be present. Thiosulfate, on the other hand, has always been found to some extent in the absorption fluid.

When thiosulfate continued to accumulate in the DEA system during the early operational period, laboratory experiments were undertaken to determine some of the conditions under which this substance would form in diethanolamine solutions. As in the case of thiocyanate formation, the reactions occurring were believed to be analogous to those that take place in an ammonium sulfide solution. Polysulfide is first formed and this then reacts with additional oxygen to form thiosulfate. The equation for the latter reaction is as follows:

(5) $$2(NH_4)_2S_2 + 3O_2 \rightarrow 2(NH_4)_2S_2O_3$$

The corresponding reaction for the enriched diethanolamine solution would be:

(6) $$[(HOC_2H_4)_2NH_2]_2S_2 + 3O_2 \rightarrow 2[(HOC_2H_4)_2NH_2]_2S_2O_3$$

The objectives of the laboratory experimental work were to determine to what extent the formation of thiosulfate was affected by the degree of saturation of the solution with oxygen, the degree of saturation of the solution with hydrogen sulfide, and the temperature of the solution. For this purpose pure diethanolamine solutions were blown with nitrogen to reduce their dissolved air content and were then saturated to different extents with hydrogen sulfide. Portions of these solutions were allowed to stand in contact with air for varying lengths of time at the ambient temperature and at the temperature used in regeneration of the DEA. Other portions of the solutions were treated similarly in a nitrogen atmosphere from which air was excluded. Following treatment of each solution, it was analyzed for thiosulfate concentration by iodimetric titration.

The laboratory data thus obtained showed that:

1. Thiosulfate formation occurs in hydrogen sulfide-enriched diethanolamine solutions in the presence of even trace amounts of oxygen, but thiosulfate formation is negligible in such a solution if air is excluded.

2. The rate of thiosulfate formation depends, in general, on the degree of saturation of the solution with hydrogen sulfide.

3. For given hydrogen sulfide and oxygen concentrations, the rate of formation of thiosulfate increases as the temperature is raised.

In order to determine thiosulfate in the presence of sulfide by iodimetric titration, the sulfide was first precipitated with nickel sulfate and then removed by filtration. This provides a satisfactory method for the routine determination of thiosulfate in rich DEA solutions. With lean DEA solutions, the thiosulfate content is also determined iodimetrically; however, in this case, treatment with nickel sulfate is usually unnecesary.

Analysis of Diethanolamine Solutions—As a result of the chemical investigation of regenerated DEA solutions for stable acidic components, a scheme of analysis was developed for the periodic testing of the lean absorption fluid. The data thus obtained have enabled the refinery to follow the

TABLE 1
Analysis of Lean Diethanolamine Solution

Appearance	Clear, Reddish-Amber Colored		
Specific gravity 60/60 F	1.0646		
Alkalinity (free DEA) expressed as weight percent DEA	9.37		
	Weight Percent		DEA Equivalent (Wt. % DEA)
Sodium (Na^+)	0.74	....	3.37
Ammonia (NH_3)	0.43	....	2.65
Carbon dioxide (CO_2)	<0.01	....	....
Organic acids, as acetic (CH_3COOH)	2.35	....	3.77
Chloride (Cl^-)	0.01	....	0.08
Total Sulfur	2.72	....	....
Sulfide ($S^=$) sulfur	....	<0.01	....
Mercaptan (RS^-) sulfur	....	<0.01	....
Thiocyanate (SCN^-) sulfur	....	1.98	6.50
Thiosulfate ($S_2O_3^=$) sulfur	....	0.68	2.23
Sulfate ($SO_4^=$) sulfur	....	0.05	0.33
		2.71	9.06
Total Nitrogen, Kjeldahl	3.41		
Ammonium (NH_4^+) nitrogen	....	0.35	....
Thiocyanate (SCN^-) nitrogen	....	0.85	....
Total (free and combined) DEA nitrogen (by difference)	....	2.21	16.55
		3.41	

TABLE 2
Comparison of the Theoretical Composition and the Analysis of a Synthetic Diethanolamine Solution

	Weight Percent of Constituents		
	Theoretical	Determined	Difference
Alkalinity (free DEA) expressed as weight percent DEA	12.61	12.65	+0.04
Sodium (Na^+)	2.24	2.20	−0.04
Ammonia (NH_3)	0.23	0.21	−0.02
Carbon dioxide (CO_2)	0.03	0.06	+0.03
Organic acids, as acetic acid (CH_3COOH)	2.20	1.95	−0.25
Total sulfur	3.03	2.98	−0.05
Sulfide ($S^=$) sulfur	0.11	0.09	−0.02
Thiocyanate (SCN^-) sulfur	2.15	2.12	−0.03
Thiosulfate ($S_2O_3^=$) sulfur	0.70	0.71	+0.01
Sulfate ($SO_4^=$) sulfur	0.07	0.09	+0.02
	3.03	3.01	−0.02
Total nitrogen	3.13	3.14	+0.01
Ammonia (NH_4^+) nitrogen	0.19	0.17	−0.02
Thiocyanate (SCN^-) nitrogen	0.94	0.93	−0.01
Total (free and combined) DEA nitrogen (by difference)	2.00	2.04	+0.04
	3.13	3.14	....

condition of the plant solution and to determine the extent of physical and chemical losses of diethanolamine from the system. A similar analysis of the rich DEA is not generally made, since it does not differ materially from the regenerated solution except in its hydrogen sulfide content. A typical analysis of the lean diethanolamine is shown in Table 1.

Table 1 shows the calculated percentage of DEA to which each constituent of the solution is equivalent. These values are a measure of the extent to which the components are capable of combining with or replacing diethanolamine and, thus, are useful in evaluating the DEA in the system.

Sulfur Balance Shown

In reporting the analysis of the lean solution, the sulfur contents of the individual sulfur compounds are shown rather than the concentrations of the sulfur-containing acid radicals. This is done so that a sulfur balance can be shown. The sulfur contents of the individual sulfur compounds are totaled and the sum is compared with the sulfur in the solution as determined by bromine oxidation. After the latter value is corrected for mercaptan sulfur, which is not converted to sulfate, the two values agree within the expected experimental error. This serves as a check on the completeness of the analysis for sulfur compounds.

In the case of nitrogen compounds, a check of this type is not made, since the total diethanolamine nitrogen is obtained by calculation rather than by analysis. The total nitrogen in the fluid is determined by a modified Kjeldahl method, and the ammonia nitrogen and thiocyanate nitrogen are obtained from the concentrations of the two constituents. The difference between the total nitrogen and the nitrogen due to ammonia and thiocyanate is reported as diethanolamine nitrogen.

Other Constituents Shown

Constituents other than sulfur and nitrogen compounds that are periodically determined in the lean DEA solutions are organic acids, chloride, carbon dioxide, and sodium. The first two were mentioned previously in the discussion of stable salt constituents. Carbon dioxide, like hydrogen sulfide, is removed in the stripping process so that only trace amounts are found in the regenerated solution. A known amount of sodium was added to the plant solution as sodium carbonate some time ago. Sodium is quickly determined with the flame spectrophotometer.

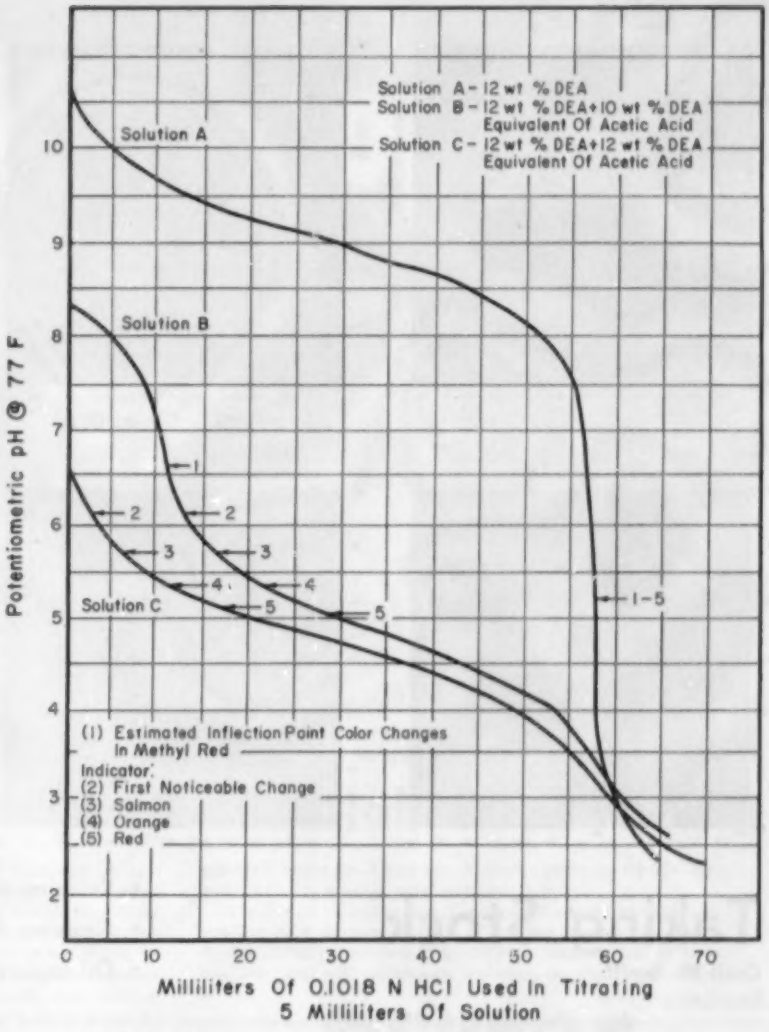
Solution A - 12 wt % DEA
Solution B - 12 wt % DEA+10 wt % DEA Equivalent Of Acetic Acid
Solution C - 12 wt % DEA+12 wt % DEA Equivalent Of Acetic Acid
Solution A
Solution B
Solution C
Potentiometric pH @ 77 F
Milliliters Of 0.1018 N HCl Used In Titrating 5 Milliliters Of Solution
(1) Estimated Inflection Point Color Changes In Methyl Red Indicator:
(2) First Noticeable Change
(3) Salmon
(4) Orange
(5) Red
1-5

FIGURE 3—How potentiometric curves compare with methyl red indicator.

In order to determine the reliability of the analytical methods as applied to the analysis of the plant absorption fluid, an analysis was made on a freshly prepared, synthetic DEA solution. The solution used for this purpose was prepared with reagent grade chemicals to have approximately the same composition as the regenerated liquid in the absorption system. The theoretical composition and the determined values are compared in Table 2.

The table shows that, in general, the analytical results on the synthetic solution give a reasonably accurate measure of the theoretical concentration of the added constituents. It may be concluded, therefore, that when these methods are used for the evaluation of plant solutions, reliable results can be obtained.

This article represents a condensation from "Detection and Measurement of Components in Diethanolomine Used for Hydrogen Sulfide Removal from Petroleum Refinery Gases," presented at the annual meeting of the California Natural Gasoline Association, October 7, 1954.

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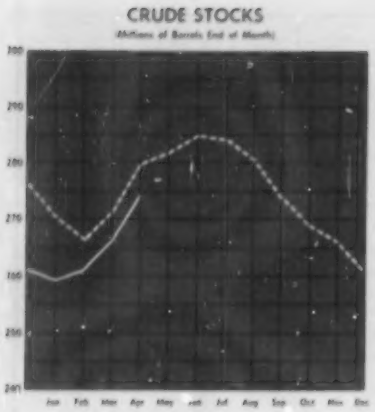
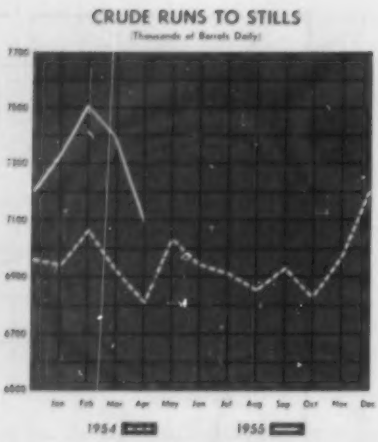
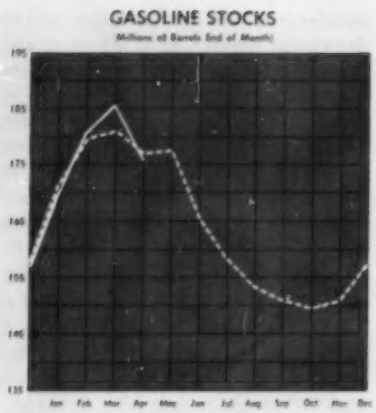
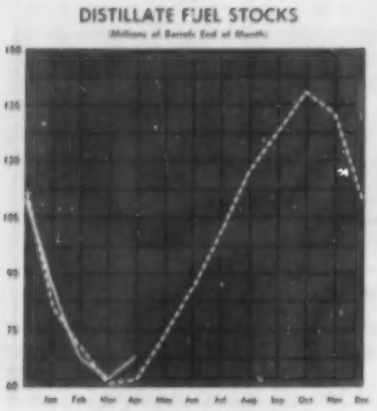
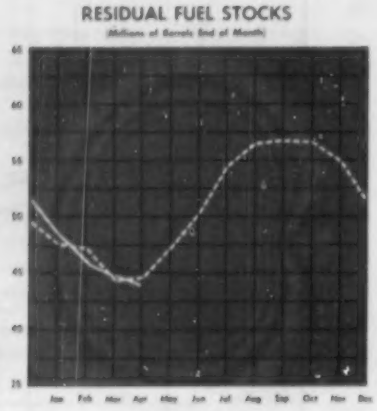
[4] Uhrig, E., and Levin, H., "Determination of Thiosulfate in Used Doctor Solution," Ind. Eng. Chem., Anal. Ed., 14, 547 (1942).

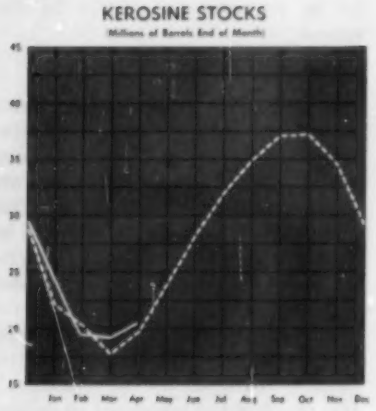












Taking Stock

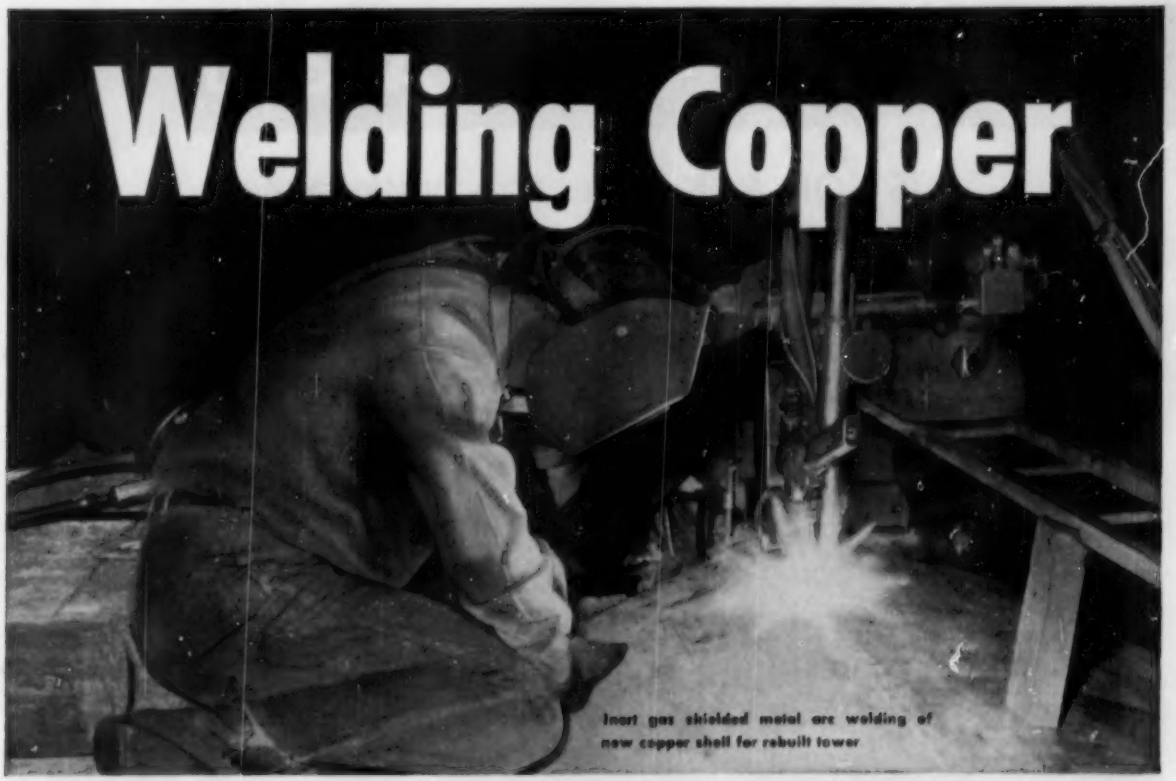
Cecil W. Smith,
Economics Editor

- Refining rates at five-month low
- Gasoline down to favorable level
- Oil imports lowest in six months

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
April	6,446	6,781	280,487	3,282	158,032	369	20,335	1,424	61,349	1,219	39,572	628	1,010
May	6,390	7,002	280,308	3,366	156,415	327	24,307	1,400	73,706	1,197	41,795	703	1,096
June	6,596	7,081	282,715	3,467	146,196	326	27,659	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	321	31,143	1,441	102,258	1,224	47,530	629	950
August	6,583	7,163	285,352	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,525	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,068
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,089	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,515	1,259	46,042	751	1,379
March	6,840	7,389	266,488	3,466	185,121	356	18,659	1,727	61,965	1,181	44,836	762	1,269
April	6,822	7,097	274,976	3,411	175,400	316	21,181	1,533	68,052	1,144	43,804	695	1,087
Week Ended:													
5-20-55	6,676	7,329	279,018	3,508	170,677	309	24,144	1,509	76,109	1,155	43,386	716	1,048
5-21-54	6,435	6,969	275,909	3,337	174,522	290	22,263	1,308	68,329	1,180	45,766	732	1,102

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

Welding Copper



Inert gas shielded metal arc welding of new copper shell for rebuilt tower

SAVES 38% in materials and labor for joining

Some time ago, the Tennessee Eastman Company, Kingsport, Tennessee, a Revere customer, began to rebuild some of its copper stills or fractioning towers, which previously would have been silver-brazed. Revere's welding specialists were called in to see whether or not welding would be superior. Demonstrations were made to Tennessee Eastman engineers and shop personnel, with the result that welding was adopted. Actual experience in the shop shows a saving of 38% in materials and labor for joining, and a better job in every way. The welding method used is the inert gas shielded metal arc process.

Reconstruction of the towers was made to reduce the number of flanges. At the same time Tennessee Eastman changed from the flange joint tray construction to the inserted tray type and incidentally, reduced the number of gaskets with their accompanying maintenance problems. The trays are salvaged by shearing off the bolt hole circle and folding up the edges. The towers are some 45' high, 6' to 10' in diameter, with a tray or bubble cap plate at specified intervals. Tennessee Eastman plans to rebuild several towers a year in this economical way.

It will pay you as it did Tennessee Eastman to look into welding as a modern method of joining copper. Remember Revere is fully experienced in the most modern and efficient methods, and will collaborate with you on their application.

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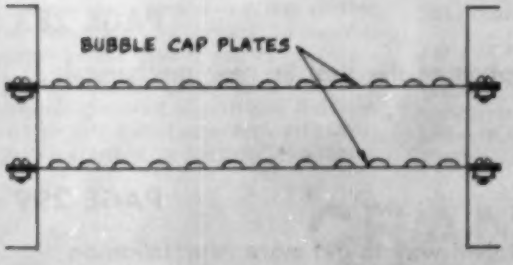
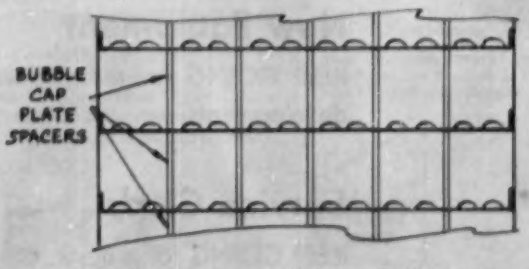


Section through old tower, showing bubble cap plates held in bolted flange.



Section through new welded tower. Bubble cap plates have had bolt holes sheared off, edges turned up. They are held in place by spacer rods.

For more data on advertised products, use Readers' Service Cards, last page.

Valuable Reading Ahead

BUSY OIL MEN . . . HERE'S A *QUICK LOOK* AT THE DEPARTMENTS IN THIS ISSUE

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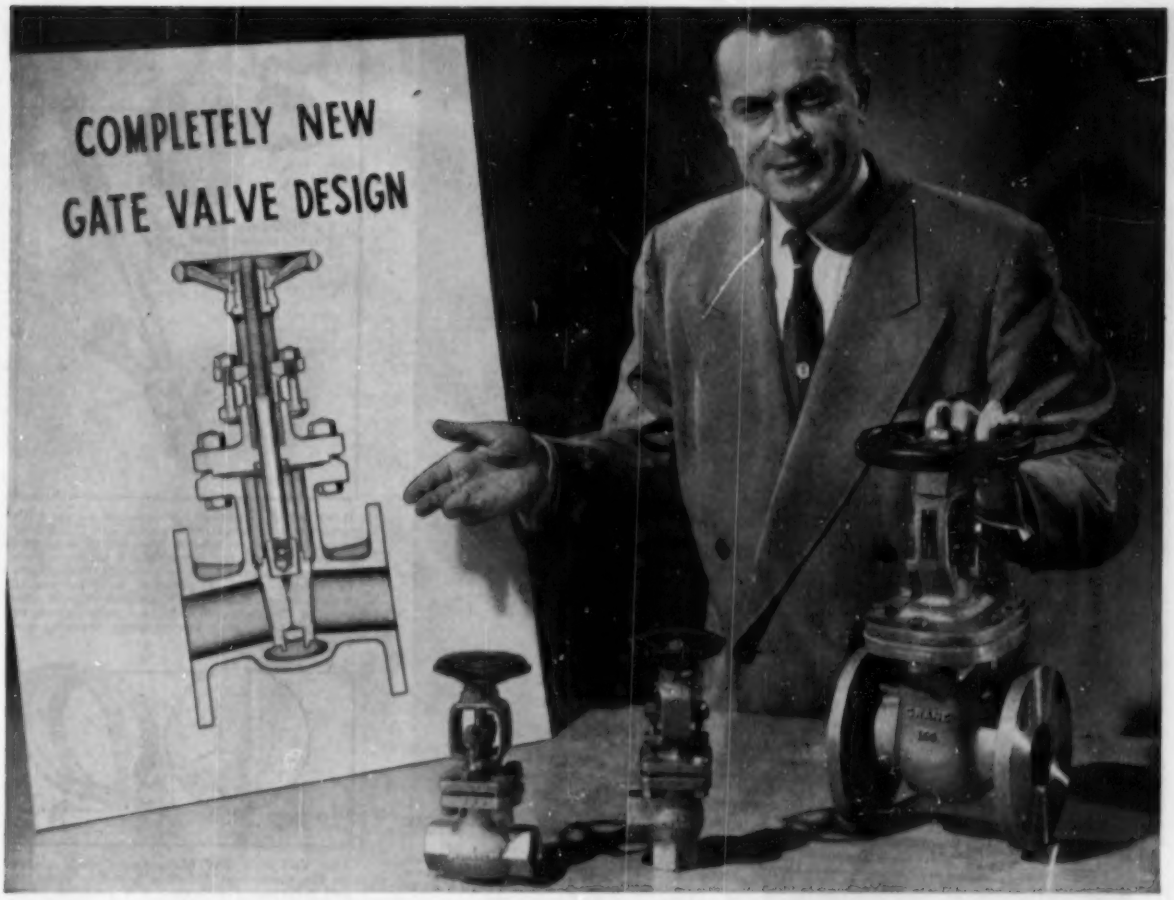


New CRANE Corrosion-resistant valves in 18-8 SMo and Craneloy 20

Gate, Globe, Angle and Check Patterns

Few valves for process industries have ever received the quality treatment given this new Crane line—at prices you'll find O.K.

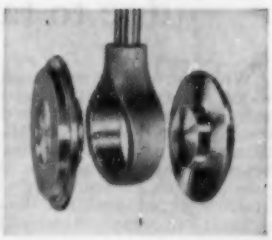
Note, for instance, the unique yet simple split-wedge disc construction in the gate valves. Those dual identical discs are free to rotate in their holder—the most effective design for resisting galling. The trunnion shape at the back of each disc assures even distribution of closing forces. You couldn't buckle them if you tried.

The globe and angle valves give equally outstanding control of corrosive fluids. A new type disc-stem connection, with minimum clearances, practically eliminates vibration. By placing seating load closer to seats, it provides easier, more accurate closure.

Check valves feature compact, thoroughly proved, non-slamming design.

Throughout, these valves are built for better service in your choice of Crane 18-8 SMo Stainless Steel or Craneloy 20. Both lines come with screwed or flanged ends.

ASK FOR THIS CATALOG—Full information including service suggestions given in circular AD-2080—available from your Crane Representative or by mail. Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers everywhere.



New split-wedge disc in gate valves combines the benefits of free rotation with uniform seat load pressure.

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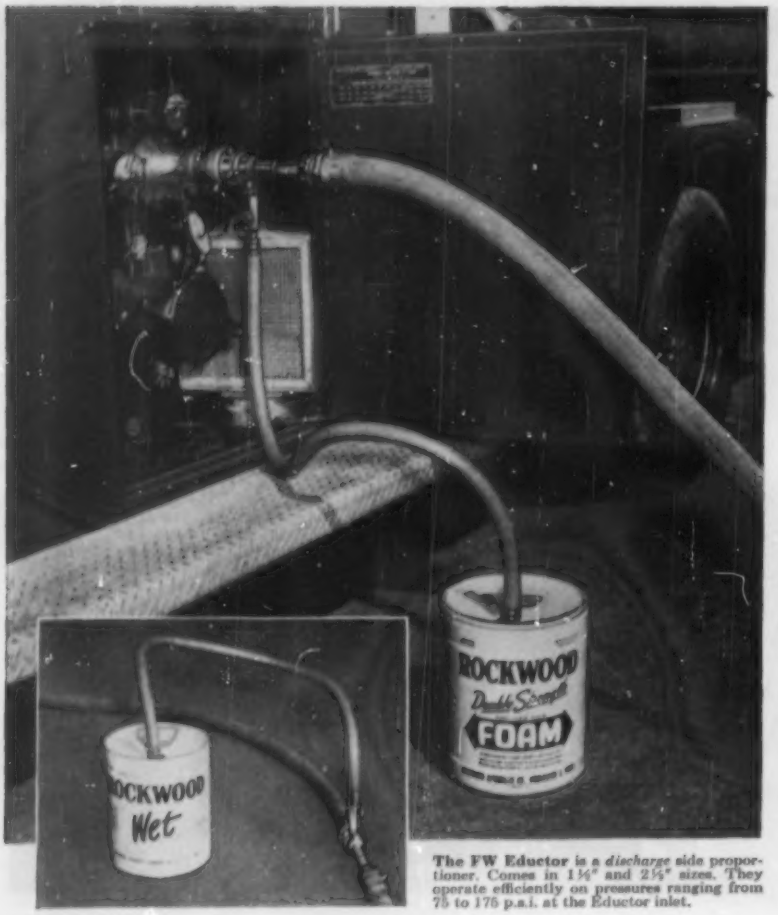
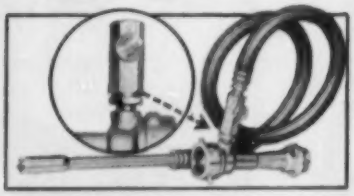


The FW Eductor is a *discharge side* proportioner. Comes in 1½" and 2½" sizes. They operate efficiently on pressures ranging from 75 to 175 p.s.i. at the Eductor inlet.

FFF Nozzle comes with Foam screen and solid Foam stream shaper.

Rockwood Eductors are designed for use with both the Rockwood FFF nozzle and the SG-60 nozzle with FF extension unit. SG-60 is an all-purpose nozzle that fights fires 5 ways — high velocity WaterFOG, low velocity WaterFOG (with applicator), FogFOAM, solid stream of water or of FOAM. FF extension unit discharges Rockwood FOAM in a solid stream or as FogFOAM, and covers large areas at one time.



The Variable FW Metering-Check Valve on the Rockwood Eductor is highly versatile, and is furnished with each FW Eductor. It incorporates both the Metering Valve and Ball Check Valve in one unit, and meters material into the hose line in any proportion from 1% through 6%.

One for the road!

Protect against flammable liquid fire due to tank truck accidents

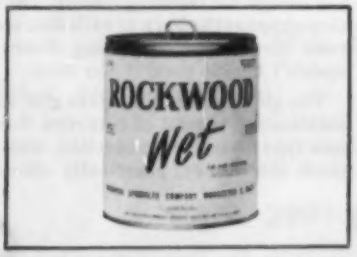
With more traffic on congested highways, more filling stations, more and more gasoline tank trucks in daily service, *your* city is in greater danger of a flammable fuel fire than it has ever been before. A sudden crash of a tank truck passing through your city streets tomorrow could confront you with a difficult-to-control flammable liquid fire.

The use of Rockwood FW Eductor reduces the danger of disastrous losses due to such a fast-spreading fire. Developed for operation with Rockwood's FFF nozzle and SG-60 nozzle with FF extension unit, the FW Eductor introduces Rockwood regular FOAM, Double-Strength FOAM or WET (1% or 2%) into the hose line, quickly controlling and extinguishing flammable liquid and other fires.

Rockwood FW Eductor is the simplest form of proportioning you can buy. Ideal for municipal fire departments, oil refineries and industrial plants, it can be attached between discharge gate of a fire truck and hose line, or between hydrant and hose line, or between two lengths of hose.

Be prepared. Put this great fire fighter to work for you. Specify Rockwood FW Eductor when you order a fire truck.

Rockwood Double-Strength Foam Liquid, 3 parts mixed with 97 parts water, forms a solid FOAM blanket that quickly re-seals itself. Available in 5-gallon or 50-gallon drums.



Rockwood WET, 1 part mixed with 99 parts water, increases penetration and extinguishing action of water. Excellent for deep seated fires or where water is scarce. Can be used in proportions of 1% or 2% by volume for Class A and B fires. Available in 5-gallon cans or 50-gallon drums.

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Engineers Water . . . to Cut Fire Losses

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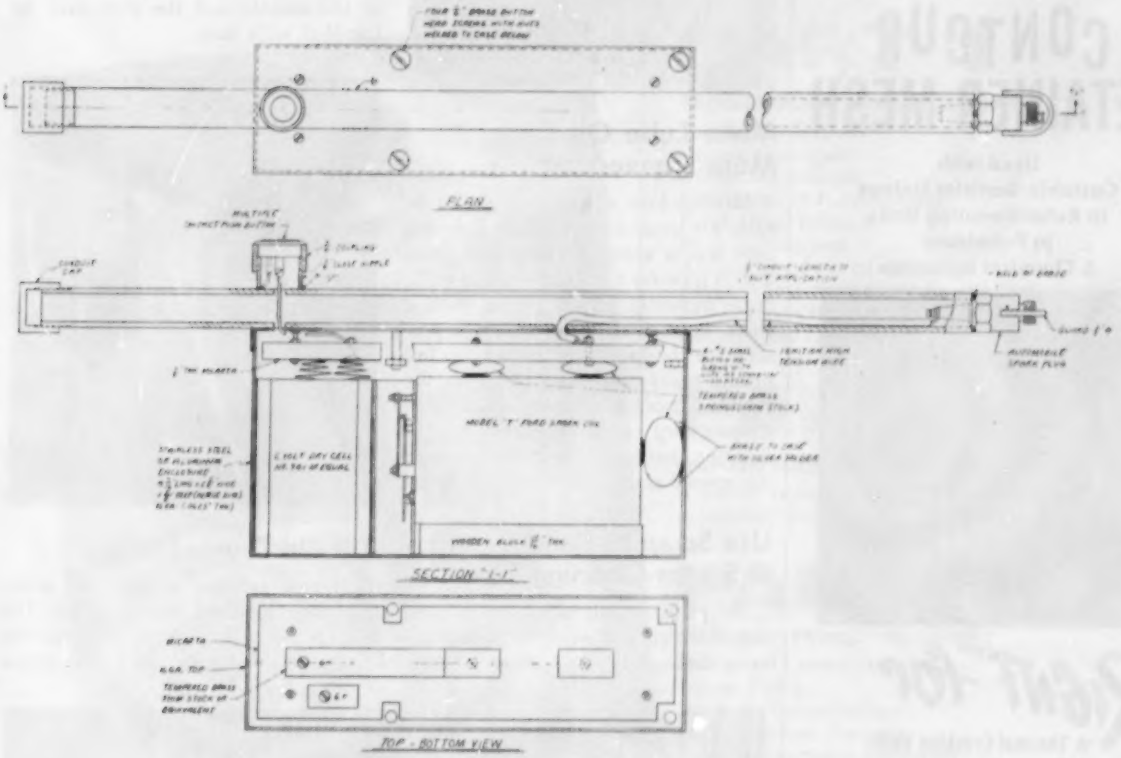


Spark-Plug Lighter Replaces Kerosine Torch

The old-style kerosine torch lighter has been replaced by a portable spark plug lighter for furnace lighting at the Sabine River Works of E. I. duPont de Nemours & Company at Orange, Texas.

The new lighter is compact and has as its essential components an automobile coil, a spark plug and a 6-volt dry-cell battery. The lighter has given safe, dependable service and has eliminated the possible fire hazard resulting from use of a flaming torch.

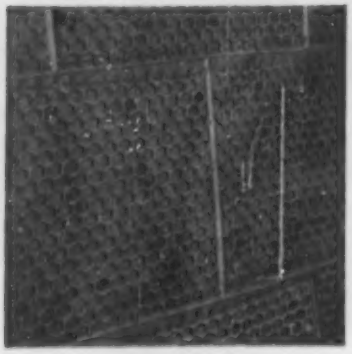
The wiring details of the lighter are shown in the diagram. The accompanying photograph illustrates its small size.

(For more How-to-Do-It items see next page.)

RIGHT WHERE IT COUNTS!

IRVING "GRIDSTEEL" CONTOUR RETAINER MESH

Used with
Castable Ganister Linings
in Refractionating Units
in Petroleum
& Chemical Industries



RIGHT for

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REDUCE EXPENSIVE SHUTDOWNS
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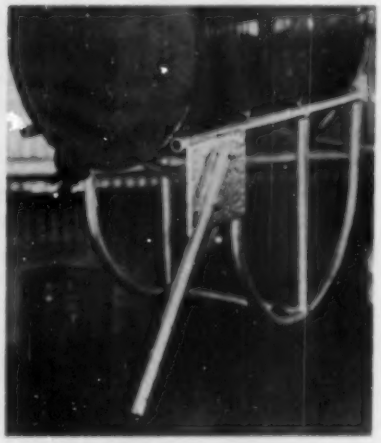
Make Lube Oil Rack More Convenient

Moving lube oil drums got to be such a chore in this plant that not only was a special rack built from 2-inch pipe for the drums but an elaborate monorail system put in with a chain hoist. This setup makes it possible for the lubricator to pick up full drums easily and place them on the rack in a horizontal position for quick dispensing of oil. The only experimenting that had to be done was with the special clamps made for the hoist.

Use Scrap to Build A Steam-Cleaning Pipe

By putting half a quick acting union which will mate with the half on a steam hose, and using a length of three-quarter inch pipe, a jet for steam cleaning may be rigged. The secret of keeping your hands from burning on the heated pipe is to run two bars of welding rod several feet on each side of the rod near the upstream end of the pipe. The welding rods will not become excessively hot in the middle and the pipe may be handled with ease.

How to Do It . . .



Tilt Oil Drums Easily

Here's another gadget to make handling lube oil drums easier. It's merely a tilter which permits the operator to take the 55 gallon drum

Here is the table of contents of one of the most valuable FREE books being offered to chemical and petroleum engineers today

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Petroleum and Petrochemical
Food, Drug, Beverage
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Advantages of ALCOA Aluminum
ALCOA Alloys Available
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A service dictionary listing over 450 products successfully handled by ALCOA Aluminum

PART 3

DESIGN OF PROCESS EQUIPMENT

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Process Piping
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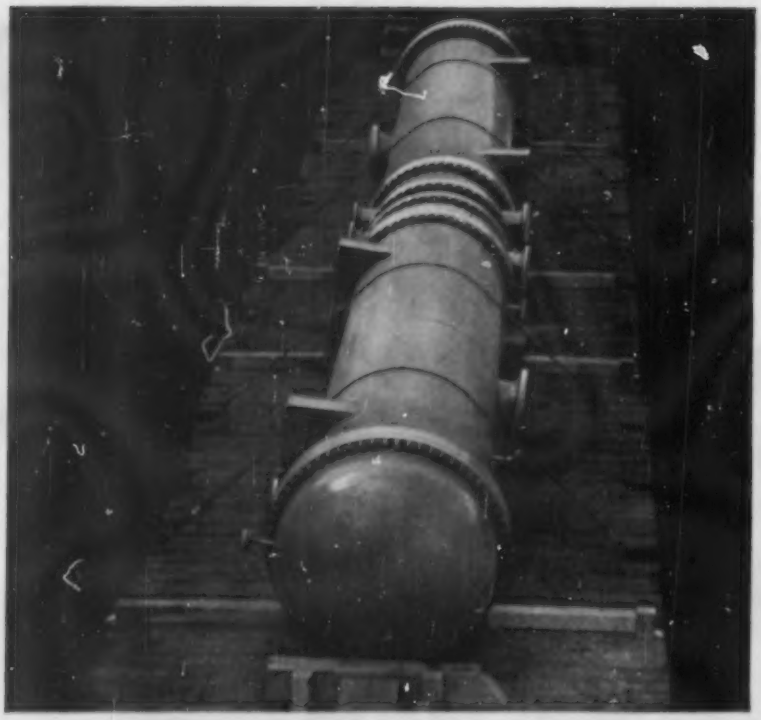

Supersonic testing adds extra value to refinery condensers by Downingtown

Supersonic testing...centrifugal casting...stress-relieved welding of Ampco 8...are some of the advanced techniques specified by Downingtown engineers in designing these two 42" x 16' inside floating head propane condensers. Essential cost savings resulted, and the condensers are highly corrosion-resistant.

Units meet ASME Code and TEMA Class R requirements in every respect. Ampco 8 was used extensively because of its higher allowable design stresses at elevated temperatures. Design pressure is 275 psi on the shell side and 100 psi on the tube side.

Each unit has 1320 Cupro-Nickel tubes ¾" O.D. x 16' 0" long. Tube sheets are of Ampco 8. The channel—a centrifugal casting of Ampco 8—was supersonically tested to assure soundness. Channel cover is of Ampco 8 lined steel. Shell and shell cover are of ¾" carbon steel. Inside floating head is a centrifugally cast Ampco 8 flange welded to a 40" I.D. x ¾" Ampco 8 head. All Ampco 8 weldments were heat-treated after welding to increase resistance to corrosion by relieving internal stresses set up during welding.

Write for further information on Downingtown experience in designing and fabricating heat exchangers and other pressure vessels for the refinery. Heat treating and X-ray testing as required by specifications.

Downingtown Iron Works, Inc.
Downingtown, Pennsylvania
New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

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How to Do It...

in its upright position and tilt it horizontally so the spigot can be used for dispensing lube oil as needed. This one was fabricated from ¾-inch pipe with a harp shape forming the two sides and a cross bar holding them together. The handle was also made from ¾-inch pipe.

Take the Danger Out Of Cooling Tower Repairs

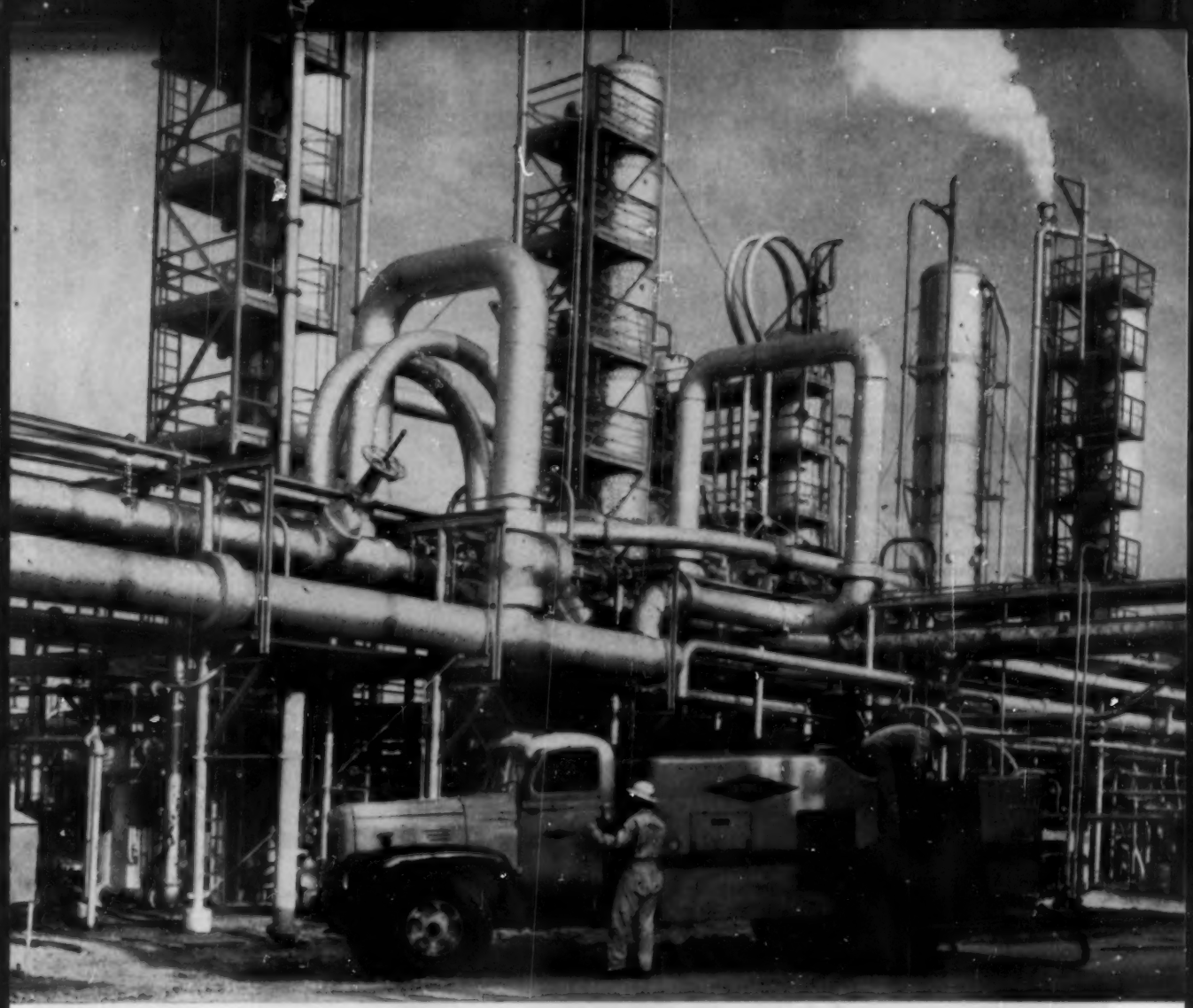
Repairing induced draft fans on a cooling tower can be a dangerous job because of the inaccessibility of the fan. Usually it is necessary to carefully drop yourself over the fan cage from the top.

One ready solution is the fabrication of two ladders. One is mounted on the outside and one is mounted on the inside. The two ladders may be fabricated from one-inch pipe in a conventional fashion. The upper ends of the ladder are curved so they will clamp on the top. This little innovation should improve safety around cooling towers.

How to Do It Ideas Are Worth Money

You have diamonds in your own back yard?

Send your ideas with photos or sketches to Editor, Petroleum Refiner, P. O. Box 2608, Houston, Texas.



SIX DAYS OF DOWNTIME SAVED

Refinery tower cleaned chemically by Dowell in only eight hours . . . a six-day saving over mechanical methods!

A refinery operator had to shut down his H_2S stripper bubble cap tower every two months to remove an oily carbonate scale. Each shutdown took seven days, because of the mechanical cleaning methods used, and even then the tower was not thoroughly cleaned.

Dowell engineers were asked to tackle the problem. They cleaned the tower in just eight hours, using chemical solvents. Visual inspection showed the tower to be free of scale with all loose deposits washed from the caps and trays. The operator of this refinery was so impressed that he adopted a regular schedule of Dowell chemical cleaning.

Dowell chemical cleaning methods are designed to reduce costly downtime, because solvents are introduced through regular connections, keeping dismantling at a minimum. Liquid solvents can go wherever gases or condensates flow —to clean angles, bends and other irregular surfaces inaccessible to mechanical methods.

You can help to maintain maximum operating efficiency in your plant by arranging for a regular program of Dowell chemical cleaning. For full information, call your nearest Dowell office, or write Dowell Incorporated, Tulsa 1, Oklahoma, Department F-31.

chemical cleaning service for industry

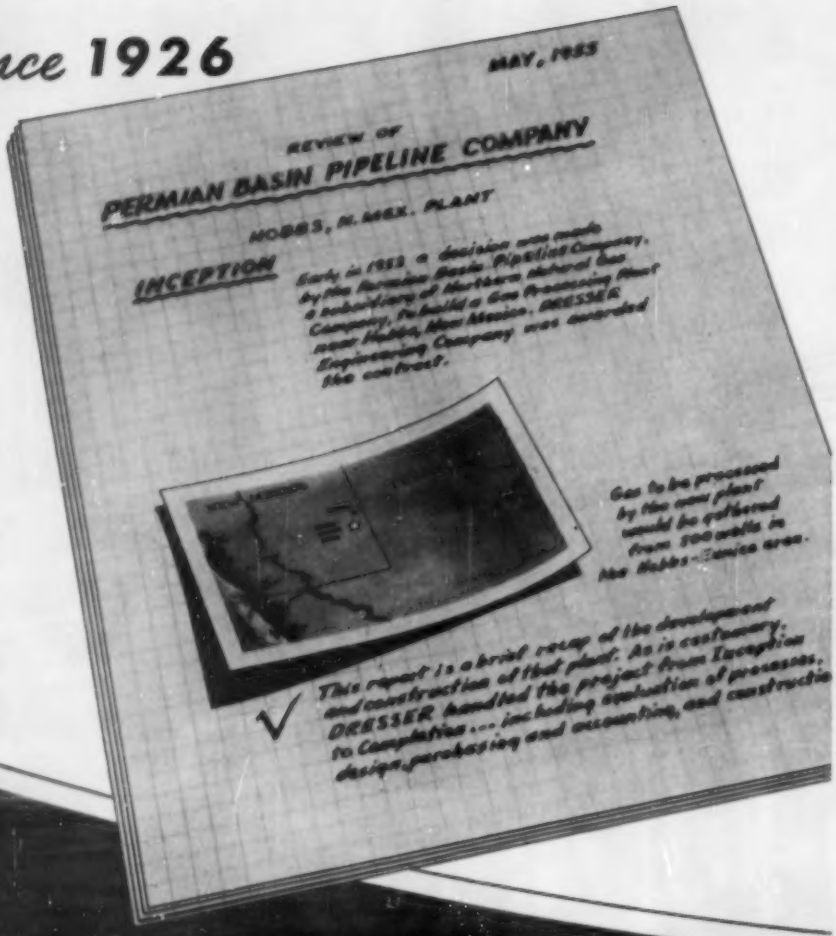
DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

DRESSER engineering COMPANY

Since 1926

This new Gas Processing Plant was designed and built by DRESSER for Permian Basin Pipeline Company, a subsidiary of Northern Natural Gas Company. It is another example of DRESSER's ability to handle complete projects from inception; including Natural Gasoline and Liquefied Petroleum Plants — Desulfurization Plants — Compressor Stations — Solid and Liquid Dehydration Plants — Pipeline Pump Stations — Recycling and Pressure Maintenance Plants — Petroleum Industry Process and Construction.


MAY, 1953
REVIEW OF
PERMIAN BASIN PIPELINE COMPANY
HOBBS, N. MEX. PLANT
INCEPTION
Early in 1953 a decision was made by the Permian Basin Pipeline Company, a subsidiary of Northern Natural Gas Company, to build a Gas Processing Plant near Hobbs, New Mexico. DRESSER Engineering Company was awarded the contract.
Gas to be processed by the new plant would be gathered from 500 wells in the Hobbs-Eunice area.
This report is a brief recap of the development and construction of that plant. As is customary, DRESSER handled the project from Inception to Completion ... including evaluation of processes, design, purchasing and accounting, and construction

COMPRESSION — Four 1320 H.P. gas engine units were installed to increase gas pressure for pipe line transmission. Air fin coolers were used to cool jacket water, lube oil cooling water, and gas.

ABSORPTION, DISTILLATION AND FRACTIONATION — Propane, butane, and natural gasoline are absorbed from the gas, then stabilized and separated from the oil by distillation. The raw gasoline is then fractionated into components which are individually treated for mercaptan removal before going to storage.

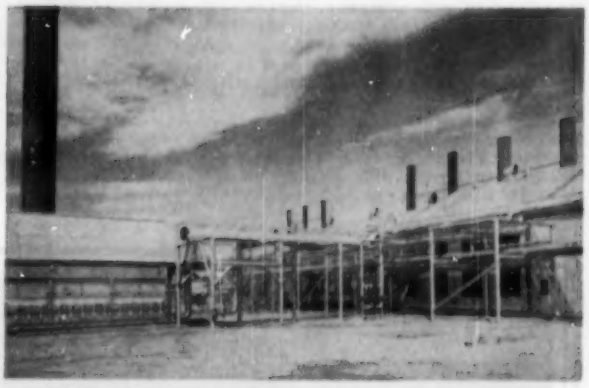
HISTORY

Design and construction of this new Gas Processing Plant began in June, 1953. Gas Treating, Dehydration and Compression facilities were placed in operation in December, 1953, and the Gasoline Plant in July, 1954. Facilities for increasing the capacity to 150 MMCFD were completed in October, 1954.

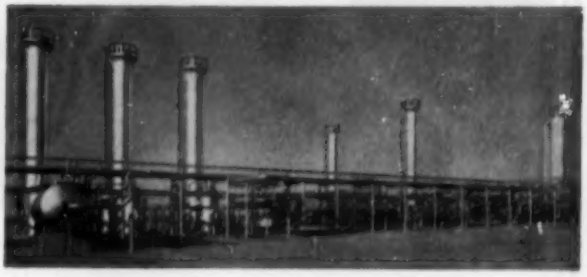
Two major premises for design were the conservation of water, and an ultimate residue gas capacity of 200 MMCFD. Air fin cooling equipment was used extensively, and major piping, oil distillation towers and product fractionators were sized for the ultimate capacity. All other vessels and accessory equipment were specified as 50 MMCFD capacity units.

In addition, DRESSER constructed warehouses for pipe line, field meter, and plant maintenance. A District Office building laboratory, and 13 homes for employees completed the project.

DRESSER's years of experience in evaluation of process, design and construction were instrumental in their being awarded this contract. Consider DRESSER for your next petroleum processing project.



BOILERS AND RICH OIL FURNACE — Steam power and process heat for the gas treating plant is furnished by four steam boilers with a total capacity of 120,000 lbs./hr. of steam. Process heat for the oil distillation and fractionation facilities is furnished by a large absorption oil heater. Dowtherm heaters furnish heat for gas dehydration regeneration.



GAS TREATING — Multiple amine-gas contactors and distillation units reflect steps in capacity growth of this plant, and give maximum flexibility for all load conditions.

DRESSER ENGINEERING COMPANY

706 S. Boston **P. O. Box 2518** **Tulsa 1, Okla.**

Reviewing New Books . . .

Strategic Planning Applied To Industrial Management

The Application of Operations Research to Industry, Johns Hopkins University, operating under contract with Department of the Army, 1955 Edition.

Techniques of strategic planning, first used by the military, now are being widely applied at the top-planning level in industrial operations. Known as operations research, these techniques take much of the guesswork out of selecting and plotting course of action and afford an informed basis for making decisions.

A report just made available to industry by the Department of Commerce's Office of Technical Services shows how operations research works. because of its practical value, the report should be of considerable interest to industry executives and others engaged in top-level, long- and short-range planning, whether they are concerned with expansion, reorganization, new products and processes or building sales.

Operations research brings to bear on a particular set of proposed actions the scientific study of an organization's capacities and performance, environment factors, consumer response and competitor capacities. The first level of operations research is concerned with comparisons of products, equipment, methods and training. The intermediate or tactical-level examinations include various types of sales promotion, new product possibilities, alternative production methods, plant locations and other phases of business and industrial operations. The strategic level examines the main, broad courses of action of an organization and determines how its strategic purposes can be best achieved.

(Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., 62 pages, $1.75.)

NACE Releases Study On Heat and Corrosion

Data on High Temperature Corrosion, National Association of Corrosion Engineers.

This book, prepared by the NACE Committee on High Temperature Corrosion, includes information on the high-temperature corrosion behavior of 31 materials ranging from cast iron to lead and including some non-metallics. The data cover a number of stainless steels and high alloys subjected to temperatures more than 400 F. Corrosion rates are indicated as low, moderate or high versus specific temperatures.

(National Association of Corrosion Engineers, 1061 M&M Building, Houston 2, 50 cents.)

Standards Recommended For Packing Petroleum

Standard Specifications for Drums and Pails, Report No. 2, Packing Institute.

Recommended standard specifications for dimensions of steel drums and lugcover universal pails have been published as Report No. 2 from the Packaging Institute's Petroleum Committee. The committee's first report covered 1-quart motor-oil cans, 5-quart and 1-gallon round cans, oblong cans, 16-gallon grease drums, 1- and 5-pound multiple-friction and 5-pound full-friction grease cans, export shipping cans, expendable pallets and standards for reconditioning drums.

The newest report includes recommended standard dimension specifications for 400-pound, 55-gallon full removable head drums; tight-head universal drums in 55-, 30-, 16- and 5-gallon sizes, and 5-gallon, 35-pound lug-cover universal pails. Each specification is accompanied by a drawing giving all pertinent dimensions.

(Packaging Institute, 342 Madison Avenue, New York 17, $1 for either report.)

Annual Asphalt Survey

Minerals Yearbook 1953, U. S. Bureau of Mines.

The first major change in the scope and coverage of the annual Bureau of Mine survey of the petroleum-asphalt industry in 32 years is reflected in a preprint chapter of Minerals Yearbook 1953. On the advise of leading asphalt producers, API and the Asphalt Institute, the bureau re-

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Armour cationics are solving a wide variety of cost and operating problems throughout the petroleum industry. If yours is a corrosion problem we recommend Armeen C and other Armour derivatives such as the Arquads® and Duomeen® TDO. If your problem is other than corrosion, our petroleum research group will be glad to assist you in solving it. Simply write us on your letterhead. Send the coupon for test samples of Armeen C and Duomeen TDO and further information on the complete Armour line of cationics for the petroleum industry.

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For more data on advertised products, use Readers' Service Cards, last page.

vised the reporting form. Data now are collected on a state rather than a refinery-district basis.

The preprint chapter, "Asphalt and Related Bitumens," discloses reported sales in 1953 of 14 million short tons of asphalt and asphaltic products, 12 percent above the 1952 total of 12.5 million. Totals of the individual items, however, are not comparable with those of previous years because of the revision in the bureau's reporting system.

(Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., five cents a copy. Should be identified as preprint from Bureau of Mines Minerals Yearbook 1953.)

Egloff Endorsed Series On Hydrocarbon Chemistry

Chemistry of Petroleum Hydrocarbons, Volumes II and III, edited by Benjamin T. Brooks, Cecil E. Boord, Stewart S. Kurtz and Louis Schmerling.

Compiled with the aid of 60 contributors, this series brings together a complete range of information of the scientific fundamentals of hydrocarbon chemistry. Major emphasis is placed on the basic chemistry of the hydrocarbons themselves. However, many industrial processes involving hydrocarbon chemistry are described, and several chapters discuss probable mechanisms of hydrocarbon reactions and the physical methods of studying the structure of complex petroleum hydrocarbons.

Petroleum engineers, organic chemists, manufacturers of chemicals from petroleum and natural gas and others interested in petroleum processing or its derivations will find these volumes a valuable reference source of fundamental hydrocarbon chemistry. Concerning one of this series, the late Gustav Egloff said:

"After studying this book, I have come to the conclusion that no one in the oil industry who has to do with the hydrocarbons of oil can afford to be without it. It is a handbook of knowledge on a subject that has been long overdue."

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, $13.50 and $18.)

Insulation Standards Set

Standards on Electrical Insulating Materials, American Society for Testing Materials.

This compilation includes the latest ASTM methods of testing and specifications for electrical insulating materials. It includes 60 methods of test, 17 specifications three recommended practices and a list of definitions. Thirty-three of the definitions are new or have been revised since the last edition was published in March 1953. This compilation includes revisions accepted as late as February 1955.

Four appendices discuss the significance of tests of insulating materials; recommendations for writing statements regarding the usefulness of tests of insulation, and two proposed methods of test—one for dielectric constant and dissipation factor of aviation fuels and one for pasted mica.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, 660 pages, $5.50.)

Aluminum's Uses Shown

Aluminum Paint and Powder, Third Edition, by Julius D. Edwards and Robert I. Wray.

This book describes the manufacture, properties and testing of aluminum powder, with special emphasis on the processes involved, color, brilliance, leafing, density, grading and handling. Full chapters discuss the composition, properties and uses of aluminum paint in a wide variety of industrial applications.

Of major interest is a large section on the uses of aluminum in plastics, rubber, explosives, lubricants and other fields. Paint technologists, coating engineers, chemists and metallurgists will find the description of properties and tests of value in determining the suitability of aluminum paste and powder for specific applications.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 212 pages, $4.50.)

Correction

Our review of *Steel Structure Painting Manual,* Volume 2, appearing in the PETROLEUM REFINER for May 1955, should have listed the price as $6 instead of $1.50. The publication, issued by Steel Structure Painting Council, contains 292 pages instead of the 96 pages indicated by our review. The council, however, has released a 96-page book, entitled *Paint Specifications.* It is this book which sells for $1.50.

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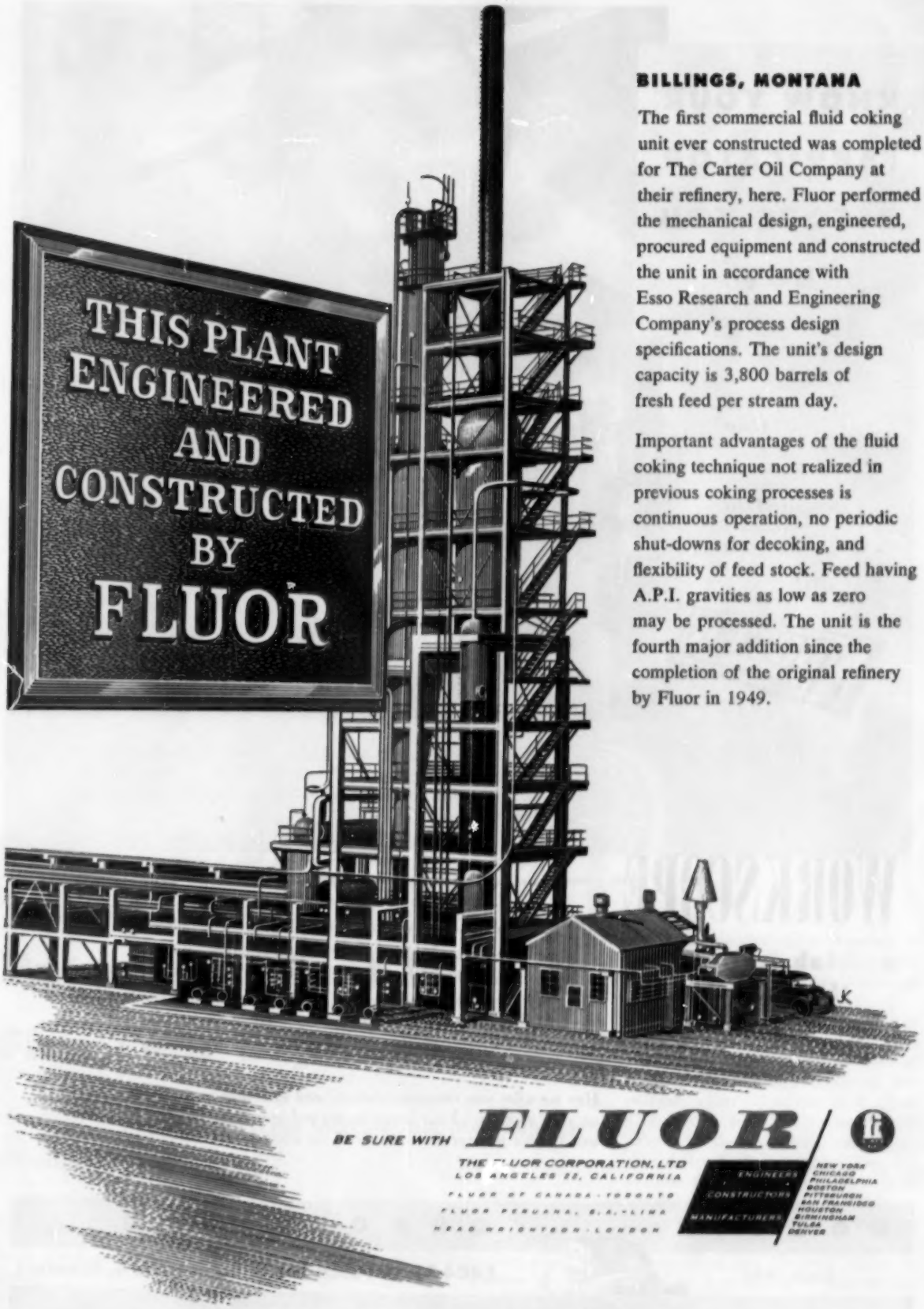

BILLINGS, MONTANA

The first commercial fluid coking unit ever constructed was completed for The Carter Oil Company at their refinery, here. Fluor performed the mechanical design, engineered, procured equipment and constructed the unit in accordance with Esso Research and Engineering Company's process design specifications. The unit's design capacity is 3,800 barrels of fresh feed per stream day.

Important advantages of the fluid coking technique not realized in previous coking processes is continuous operation, no periodic shut-downs for decoking, and flexibility of feed stock. Feed having A.P.I. gravities as low as zero may be processed. The unit is the fourth major addition since the completion of the original refinery by Fluor in 1949.

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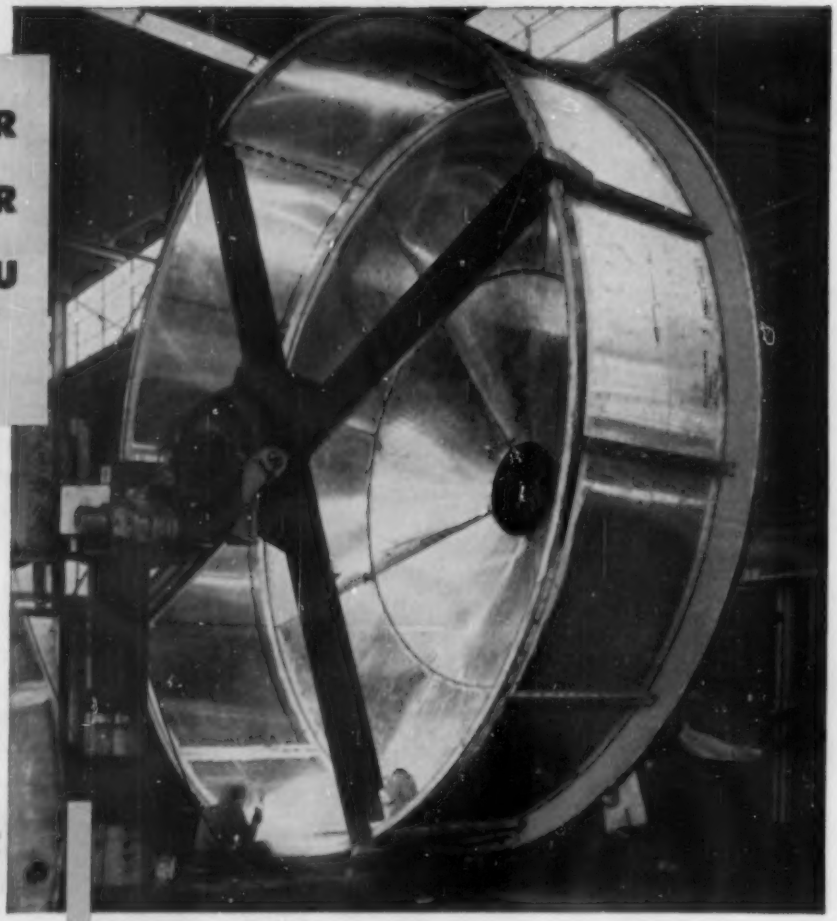

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Who's Building . . .

(Petroleum REFINER's exclusive quarterly feature, Construction Boxscore, will appear next month)

Petro-Tex Chemical Corporation to operate Houston plant.

Butadiene Plant Sets Five-Year Expansion

. . . Fifty-percent increase in automobiles predicted in five years.

THE SECOND LARGEST butadiene plant in the U. S. will be expanded by 50 percent within the next five years. Plans of the new Petro-Tex Chemical Corporation, formed to operate the 90,000-ton-a-year plant recently acquired at Houston, also call for construction of a $1.5-million basic- and applied-research center in the New York area. The new center will be devoted to petrochemical studies.

Expansion of the company's Houston plant will be synchronized with expansion of Goodyear Synthetic Rubber Corporation's adjoining copolymer plant. Goodyear will spend $750,000 to increase production 50 percent at the Houston plant it purchased from the government for $11,889,000. Ultimately 25 percent of Goodyear's Houston output will be in cold rubber, with the balance going to hot rubber.

Growth of the Houston plants is based on a predicted 50 percent increase in the number of cars on the

Who's Building . . .

road within five years.

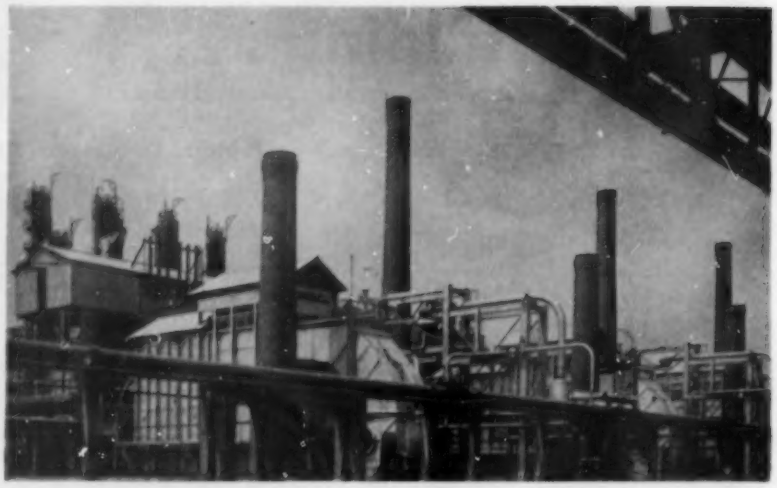
But butadiene output for synthetic rubber will form only a nucleus for Petro-Tex's activities in Houston. Butadiene will be the company's first move into the whole petrochemical field. This shift in the use of butadiene has been limited up to now because of insufficient production.

The plant was sold by the government to Food Machinery & Chemical Corporation, which with Tennessee Gas Transmission Company has organized the Petro-Tex Company to operate the facility. The two companies hold equal interest in the new Houston producer.

Actual construction for expansion will begin by January 1956, but it probably will require an additional 12 to 15 months to put the first of the additional facilities into operation. Petro-Tex expects to spend about $1 million a year for several years in expanding the Houston plant.

Sinclair Refining Company, whose subsidiary Sinclair Rubber Corporation operated the plant for the government and was an unsuccessful bidder for it, will continue to supply butylene from its nearby refinery. The bulk of the plant's raw material, however, will be butane. TGT has uncommitted supplied of butane and is in a position to gather additional supplies.

The butadiene plant's operating personnel, some 450 technicians, continue in the assignments they held under Sinclair management. Officers and directors were named from FMC and TGT personnel. (See Men in Industry.)



Houston Plants to be Synchronized—
Expansion of the Petro-Tex Chemical Corporation's butadiene facilities will be coordinated with plans to increase production of the adjoining copolymer plant recently acquired by Goodyear Synthetic Rubber Corporation. Feed stock pre-heaters at the butadiene plant are shown, with steam super-heaters at the right.

Planned and Projected:

Imperial Oil, Ltd., will build facilities to produce a new wax at its $4.5-million wax plant recently completed at Sarnia, Ont. Construction, scheduled to begin this fall, will be completed early in 1957.

Humble Oil & Refining Company will start construction this month on a new casinghead gas processing plant in the Neches field, between Palestine and Jacksonville, Texas. The project is scheduled to be completed in October.

The plant will be a conventional oil-absorption type with refrigeration. Design to process 11 Mmcf. of gas a day, the plant is expected to recover approximately 53,000 gallons of liquid products a day.

The contract for construction was awarded to Fish Engineering Corporation, a Houston firm.

The Standard Oil Company (Ohio) will build a $4.4-million Ultraformer at its Lima, Ohio, refinery. The unit, designed for a daily capacity of 11,000 barrels, is expected to be finished next spring.

This is the second catalytic-reforming unit to be added to Ohio Standard's refinery equipment. The first was a Platformer, now in operation at the Lima plant. Installation of the new unit will be handled by The Fluor Corporation, Ltd.

Cities Service Oil Company will increase the capacity of its Ponca City, Okla., refinery by 10,000 barrels a day, as part of an expansion calling for some $2 million to be spent there this year and next. The plant currently is processing about 23,000 barrels a day.

Sinclair Refining Company will add a carbon-monoxide boiler to its 34,000-barrel-a-day fluid catalytic cracker at East Chicago, Ind. To convert waste cracker heat to steam, this will be the second such unit to be added to Sinclair refinery equipment. The other boiler is at the Houston refinery.

The American Oil Company has given The Lummus Company the contract to build a delayed-coking unit at its projected Yorktown, Va., refinery. This is one

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The new Australian refinery primarily consists of crude oil distillation, catalytic cracking, decarbonizing and polymerization units with deep marine, storage, and other yard facilities. The Power Plant is shown here under construction.

UNDER WAY "DOWN UNDER"

At Botany Bay, near Sydney, Australia, Kurnell Refinery soon will go "on stream." Designed for completely integrated processing of 22,000 barrels per calendar day of Eastern Hemisphere crude oils, it is a project of our client, Australian Oil Refining Limited, an affiliate of California Texas Oil Company, Limited.

Stone & Webster Engineering Corporation and its British affiliate, E. B. Badger & Sons Limited, are responsible for the design of the crude oil distillation unit and yard facilities and for the construction management of the entire project.

Crude Oil Distillation Unit under construction

Decarbonizing Unit under construction

Catalytic Cracking Unit under construction

Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

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Yet it is the lightest and most flexible of all covered fire hose! Ask the fire crews who handle it.

A fast-running, husky fire crew can pull it over jagged concrete, around sharp pillars—without any damage to it. Kinking or being run over does no harm. Even rats and termites can't chew it (believe it or not, over 600 feet of ordinary fire hose were eaten up last year in just *one* Texas plant). U. S. Matchless® has a special cord ply carcass made of "Ustex" fabric, resistant to rot and mildew. The white (or black) oil-proof neoprene cover resists oils, acids, fumes and strong, hot sunlight.

Other hose made by United States Rubber Company for the refining and petro-chemical fields include:

- Flexlite, the all-Dacron* Single Jacket (weighs 48 lbs. per 100 ft.) (withstands 500 lbs. test pressure)
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Who's Building . . .

in a series of contracts awarded for construction of the 35,000-barrel-a-day plant. The general contract went to The M. W. Kellogg Company.

When American, a Standard Oil Company (Indiana) subsidiary, completes its Virginia plant next summer, the consolidated refining capacity of the parent company and its affiliates will be expected to take care of anticipated sales until 1960.

California Research Corporation will build a new wing on its main administration-laboratory building at Richmond, Calif. The new addition, expected to cost more than $500,000, will be the second phase of a $1.5-million expansion program undertaken by the Standard Oil Company of California subsidiary last year. A new engine laboratory is nearing completion.

Neste Oy, controlled by the Finish government, has awarded the contract for construction of its 18,000-barrel-a-day refinery at Turku to a U. S. company. The refinery, to be Finland's first and the world's northernmost, will be built by The Lummus Company, selected to handle both engineering and construction.

Designed to handle crude from the Middle East as well as the Black Sea area, the new installation will process 750,000 tons a year and supply the substantial part of the country's petroleum requirements. Finland's present demand runs to nearly 20,000 barrels a day.

The balance of the plant's product will be turned out in about the same proportions as in average U. S. refineries. Distribution is expected to be handled mainly through companies already doing business in Finland.

British Petroleum Company plans to install a catalytic oil gasification unit at its refinery in Kent. To be built for converting hydrocarbons ranging from butane to heavy fuel into gas, the unit will have a daily capacity of 15 Mmcf.

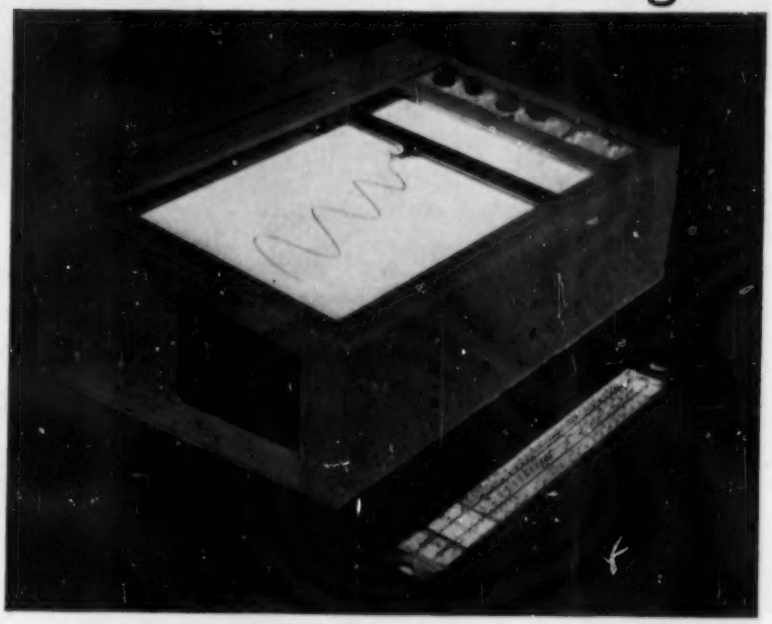
Fabrica Argentina de Fenol y Derivados, S. A. will build a 1800-ton-a-year plant to produce phenol and its derivatives at San Nicolas, Argentina. Expected to represent a $375,000 investment, the new plant is scheduled for completion by fall 1956.

A German firm, Farbenfabriken Bayer, initiated the project and is expected to furnish about 35 percent of the money. The remaining interest will be in the hands of two Argentine companies, Bunge & Born Ltda., S. A., and Compania Quimica, S. A.

Continental Oil Company will further expand its Ponca City, Okla., refinery to include a dairy-wax plant with an annual capacity to produce 11 million pounds of wax. The new plant, representing an additional investment of approximately $500,000 in Conoco's Ponca City refinery, is expected to be completed early in 1956.

Completion of the new wax plant will bring the company's annual production

News in X-Y Recording



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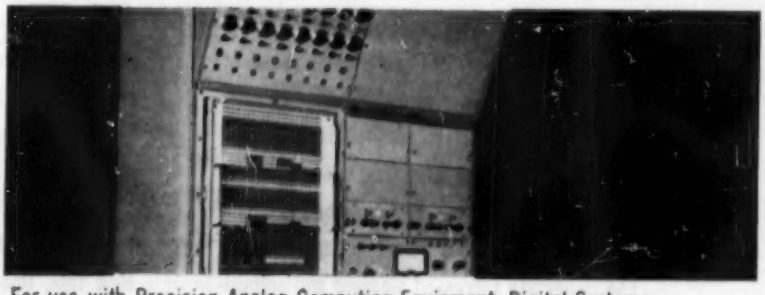
Including vacuum hold-down for plotting paper, finer accuracy, faster response



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Variplotter Model 1100 – Provides rapid (pen slews at approximately 20" per second) graphic recording of any data that can be reduced to electrical form. Same reliable accuracy as the well-known 205 series Variplotter. Ideal where compactness is essential without loss of speed or performance. Designed for use in recording computer outputs (as with EAI 16-31R pictured above), generating functions, or with additional equipment – for plotting digital information from punch cards or tape. For complete brochure write Department PR-8 Electronic Associates, Inc., Long Branch, New Jersey.

ELECTRONIC ASSOCIATES Incorporated — EAI SETS THE P PRECISION A ANALOG C COMPUTING E EQUIPMENT

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Tuesday night, September 28th: the Lummus initial operating team first fed oil into the crude unit of the 30,000 B/D refinery which Lummus designed, engineered and constructed for a major oil company at Mandan, North Dakota.

Wednesday night, September 29th: oil was fed into the fluid catalytic cracking unit.

Friday night, October 1st: the entire refinery was in operation at two-thirds capacity, with products going to storage.

Mandan refinery starts up in three days

The Mandan refinery was completed ahead of schedule, started up in record time, and has been operating ever since. It is an integrated plant including crude distillation section, fluid catalytic cracking unit, vapor recovery section, polymerization unit, treating and blending sections and desalter.

The owner has expressed pleasure and enthusiasm over the excellent time and performance records on the installation, made possible through painstaking engineering and construction efforts.

This adds one more to the over 700 efficiently engineered and constructed projects which Lummus has brought to completion over the past 50 years. May we work with you on your next project.

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LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

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of dairy wax to 20 million pounds. Currently, the company produces 9 million pounds a year, with output coming principally from the Cit-Con Oil Corporation plant, owned jointly by Continental and Cities Service Oil Company at Lake Charles, La.

Anglo-Canadian Oil Company, Ltd., will begin a $75,000 expansion program at its Brandon, Man., refinery. The new expansion, the second in eight months, will include the construction of a $50,000 skimming tower and a $25,000 high-loading platform.

Ashland Oil & Refining Company will install additional crude-distillation and catalytic-cracking facilities at its largest refinery, near Ashland, Ky. Also at the refinery, a project to add a 6000-barrel-a-day catalytic-reforming unit was proceeding on schedule, with construction due for completion this month.

New equipment and auxiliaries, estimated to require 15 months to build, will give the refinery a 55,000-barrel-a-day capacity and bring the company's total output of modern refining to more than 100,000 barrels a day. In addition, the company will have 50 barrels a day of refining capacity in good operating condition, which will be fully depreciated and available for use as needed.

Northern Chemical Industries, Inc., has awarded the contract to build its second Monsanto-type contact-acid plant at Searsport, Me. The new facility, due to be installed by Leonard Construction Company, will be built to produce 100 tons a day of 100-percent sulfuric acid.

This, combined with existing units, will give the company a total rated capacity of 170 tons a day, with actual production going as high as 220 tons. The project is scheduled for completion in January 1956.

In March 1956, Northern Chemicals will finish its 125-ton-a-day anhydrous-ammonia plant and 65-ton-a-day nitric-acid facilities now under construction at Louisville, Ky. The Girdler Company is building the new Kentucky plant.

Phillips Petroleum Company, with Magnolia Petroleum Company, will build a natural-gasoline liquids-extraction plant near Lindsay, Okla. Phillips will operate the jointly-owned plant.

The new unit will process gas originally intended for sale to an interstate pipeline. Sales will be switched, however, to distributors inside the state to avoid Federal Power Commission controls.

Shell de Venezuela will spend $36 million this year on new installations at its Punta Cardon refinery. New facilities will include a catalytic-cracking unit, a polymerization unit, two treating units and two feed-preparation units.

Monsanto Chemical Company has set aside $2,040,000 for construction of polyvinyl-chloride-resin facilities at Springfield, Mass. The new installation, due for completion early in 1956, will be built for an annual output of 26 million pounds.

The Carter Oil Company will build two new processing units at its Billings, Mont., refinery. Work was to begin immediately on a 6900-barrel-a-day hydrofiner and a catalytic reformer geared for 2500 barrels a day. The units will be built by The Fluor Corporation, Ltd., which expects to complete the project by January, 1956.

Montecatini Chemical Company, an Italian firm, has entered a contract with the Venezuelan government to build a fertilizer plant. Plans call for the Venezuelan plant to be built for an annual capacity of 30,000 tons.

The Venezuelan government has selected Puerto Cabello as the site another petrochemical plant. The new facilities will produce 150,000 tons of fertilizers and 50,000 tons of fertilizers and 50,000 tons of explosives. Due for completion by the end of 1957, the plant will cost up to $30 million.

Also planned for construction at Puerto Cabello is a refinery. The plant will be built by Socony-Vacuum Oil Company of Venezuela.

Stauffer Chemical Company plans call for construction of a carbon-bisulphide plant at Mobile, Ala. Construction of the new plant will be underway immediately, with a completion date set for spring 1956. To use a newly-developed process, the plant is expected to enjoy a favorable raw-material position, particularly with respect to natural gas and sulphur.

Venezuela Gulf Refining Company is considering the installation of an 8000-barrel-a-day catalytic reforming unit at its 30,000-barrel-a-day refinery near Puerto La Cruz, Venezuela. The company is owned two-thirds by Gulf Refining Corporation and one-third by two affiliates of The Texas Company.

Sunray Oil Corporation will build a gas-processing plant at Church Point, La. Scheduled to be completed this fall, the new installation will be built for a maximum line output of 27 Mmcf. of gas under 3000-pound pressure.

A contract, let to Tuloma Builders, Inc., also calls for erection of a plant office building, machine shop and laboratory, as well as permanent roads for the plant area. Work is to begin shortly.

Ketona Chemical Corporation has completed engineering on its nitric-acid-neutralizing and ammoniated-nitrate-of-ammonia facilities at Tarrant, Ala., and awarded a contract for construction to The Fluor Corporation, Ltd. Ketona Chemical is owned jointly by Alabama By-Products Corporation and Hercules Powder Company.

The two units will be in addition to a new anhydrous-ammonia plant Fluor is building for Ketona at Tarrant. The latter will be built for an annual capacity of 45,000 tons.

The nitric-acid plant will have a daily output of 60 tons, while the ANA installation will be geared for twice that amount. Construction on the two units will begin in August, with the plants scheduled to go into operation early next year.

Who's Building . . .

Hidalgo Chemical Heads Fast Write-Off Approvals

The biggest fast write-off for the petroleum industry in recent weeks went to Hidalgo Chemical Company. The government authorized the Stanolind Oil & Gas Company subsidiary to write off 70 percent of $3,428,000 worth of equipment at a still-unopened natural-gas-synthesis plant in Brownsville, Texas. Certification covers a synthesis-gas generator, catalyst-activation facilities and related auxiliaries.

Warren Petroleum Corporation received the second largest grant of rapid write-off allowances. The government gave the company a certificate permitting it to amortize 65 percent of $1,814,303 at the fast rate. Warren will invest the money in 1525-barrel-a-day natural-gasoline plant in Wise County, Texas.

Warren received another certificate for expansion of its natural-gasoline plant at Monument, in Lea County, N. M., to produce an additional 4000 barrels a day of LPG products. Certification was made for 65 percent on $628,680.

Big West Oil Company was certified for construction of a 650-barrel-a-day catalytic-reforming unit and a 1000-barrel-a-day catalytic hydrogenation unit at its Kelvin, Mont., refinery. The government will permit amortization on $492,400 at 65 percent and on $91,000 at 45 percent.

Phillips Petroleum Company was cleared for amortization on a project to increase the capacity of a natural-gasoline plant in Hutchinson County, Texas, by installing additional processing equipment and extending its gas-gathering pipeline system. The government will allow 65 percent on $362,000 and 40 percent on $142,000.

Phillips Petroleum also will be allowed to amortize the installation of treating facilities for removing sulphur from 7142 barrels a day of mixed butane at its natural gasoline plant at Phillips, Texas. Write-off certificates were issued for $101,000 at 65 percent.

Another certificate was issued to Salt Lake Refining Company for construction of jet-fuel and aviation-gasoline-blending and testing facilities at the company's Salt Lake City refinery. The company will be allowed a 100-percent fast write-off on $282,000.

Skelly Oil Company was approved for construction of an isobutane fractionator and treater at its natural gasoline plant at Eunice, N. M. The units, to be built for a daily capacity of 310 barrels of isobutane, was certified for $106,000 at 100 percent and $90,000 at 65 percent.

Under Construction:

Escambia Bay Chemical Corporation has started construction on its petrochemical plant near Pensacola, Fla. Cost of the new plant, including other facilities to be added later, is expected to run to more than $25 million.

The plant will produce as much as 250 tons a day of anhydrous ammonia, from which a daily output of 220 tons of nitric acid, 275 to 350 tons of ammonium nitrate and 200 tons of ammonium nitrate-ammonia fertilizer may be developed.

Completion of construction work by

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First determine how much condensate you'll have in the system at the peak load. When this is not known it can be easily figured by referring to the Anderson book "Solving Steam Trap Problems." However, to provide for a margin of safety the rating of the trap should be more than the condensate to be handled. The capacity rating factor should be at least two and sometimes as high as six, depending upon the steam condensing surface, the air to be vented as well as the type of trap used. By using Heat-Kwiks you never need a factor of more than 2 to 1. Therefore you get by with a smaller, less expensive unit.

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the Engineered Steam Trap by
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Who's Building . . .

Chemical Construction Corporation, is scheduled for January, 1956. The initial production of two primary units will be industrial chemicals, direct fertilizers and components of mixed fertilizers. Two basic production units will be added to produce polyvinyl chloride.

The new chemical company was organized by United Gas Corporation, Electric Bond & Share Company and National Research Corporation.

Spencer Chemical Company, which recently completed a $15-million polyethylene plant at Orange, Texas, is nearing completion of its new nitrogen-producing facilities at Henderson, Ky. Due for completion next month, the plant is expected to cost $1,750,000.

The company also is building additional nitrogen facilities at its plant in Vicksburg, Miss. The installation under construction there is estimated to cost $1,500,000. It is scheduled to be completed early next year.

Spencer's plant at Orange was built to produce 45 million pounds of polyethylene a year.

Humble Oil & Refining Company is nearing completion on two new 18,000-barrel-a-day Hydroformers now under construction at its refinery in Baytown, Texas. One unit is scheduled for completion sometime this month, and the other unit is expected to be finished in August. The units were estimated to cost $4 million each.

The Standard Oil Company of Ohio has a new catalytic-polymerization unit under construction at its refinery in Lima, Ohio. Expected to cost $335,000, the new facility is due to go into operation this fall.

Also scheduled for completion at Lima this fall is a $17-million petrochemical plant. The installation will give Standard a daily production capacity for 300 tons of anhydrous ammonia, 60 tons of nitric acid and 200 tons of nitrogen solutions.

Texas Natural Gasoline Corporation is due to have its new Coke County, Texas, gasoline plant in operation by fall. A gathering system was completed this spring.

Construction of the 70-Mmcf plant is being handled by The Fluor Corporation, Ltd., which will install compression facilities, including five 2000-h.p. compressors; gas processing and dehydration facilities; storage facilities for liquid products; electrical generator facilities; boilers and auxiliaries, and water-treating facilities.

In addition to natural gasoline, the plant will produce butane, isobutane and propane. It is expected to bring Texas Natural Gasoline's daily output of natural-gas liquids to more than 800,000 gallons a day.

Frontier Refining Company has started construction on a 2500-barrel-a-day Platformer and a 3000-barrel-a-day Unifiner at its refinery near Cheyenne,

Who's Building . . .

Wyo. The new additions, being installed by Procon, Inc., are part of a $1.5-million program which also calls for an increase in the plant's charging capacity from 10,000 barrels a day to 12,500 barrels.

Caltex (Africa), Ltd., is installing facilities for blending lubricating oil at its Island View terminal near Durban, South Africa. Now underway, construction of the $600,000 installation is scheduled for completion by summer 1956.

Additions to the terminal will include a homogenizer, built for an hourly capacity of 125 barrels. The new homogenizer is a modern unit providing continuous, automatic feeding.

Calumet Nitrogen Products Company has started construction on its nitrogen products plant at Hammond, Ind. The plant, due for completion in May, 1956, will be built for a daily output of 300 tons of anhydrous ammonia for fertilizer and industrial chemicals.

Recently organized by Sinclair Refining Company and Standard Oil Company (Indiana), the company will be furnished raw materials for its plant from Sinclair's refinery at East Chicago and Standard's refinery in Whiting. Standard will operate the plant for Calumet, with Standard and Sinclair each marketing its portion of the plant's output separately.

McColl-Frontenac Oil Company, Inc., is scheduled to complete a 3000-barrel-a-day Thermal Cracking unit this month at its refinery in Edmonton, Alta. Also due for completion this month is a 12,000-barrel-a-day Platformer being installed at the Canadian company's Montreal East refinery.

Completed:

The British Petroleum Company, Ltd., has put a new Platformer on steam at its Kent refinery, near London. The unit, built for a daily capacity of 6000 barrels, is producing a high-grade gasoline component.

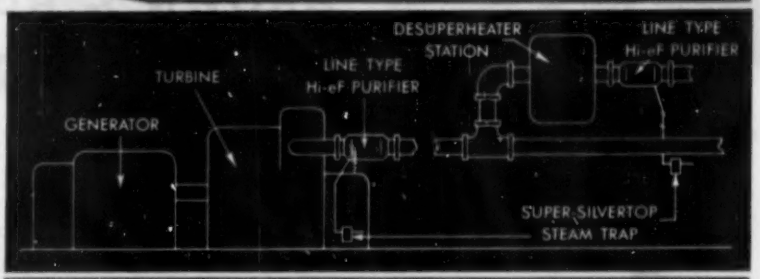
Another Platformer is nearing completion at the company's Llandarcy refinery in South Wales, while foundations are being laid for still another unit at the Porto Marghere refinery, near Venice Italy.

Midwest Research Institute has completed a new research laboratory in Kansas City, Mo. The new installation was built at a cost of $1,250,000.

Gulf Oil Corporation has gone into operation with a new 10,000-barrel-a-day Platforming unit at its refinery in Toledo, Ohio. This is the second of four such units being built for the company to go on stream.

The new facility is designed to produce a debutanized reformate of 98 F-1 octane

Case Study No. 102



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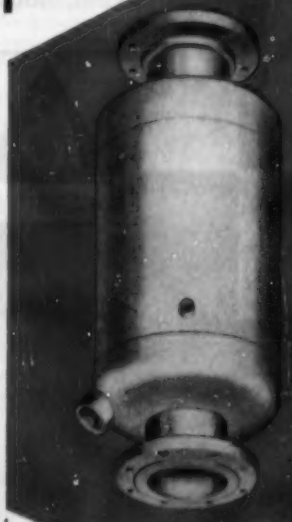
Company officials are enthusiastic about the quality maintained by the Hi-eF Purifiers. Since they have no moving parts they will continue to give maximum protection with a minimum of maintenance to the turbine and deliver dry, clean steam to the processing equipment for many years.



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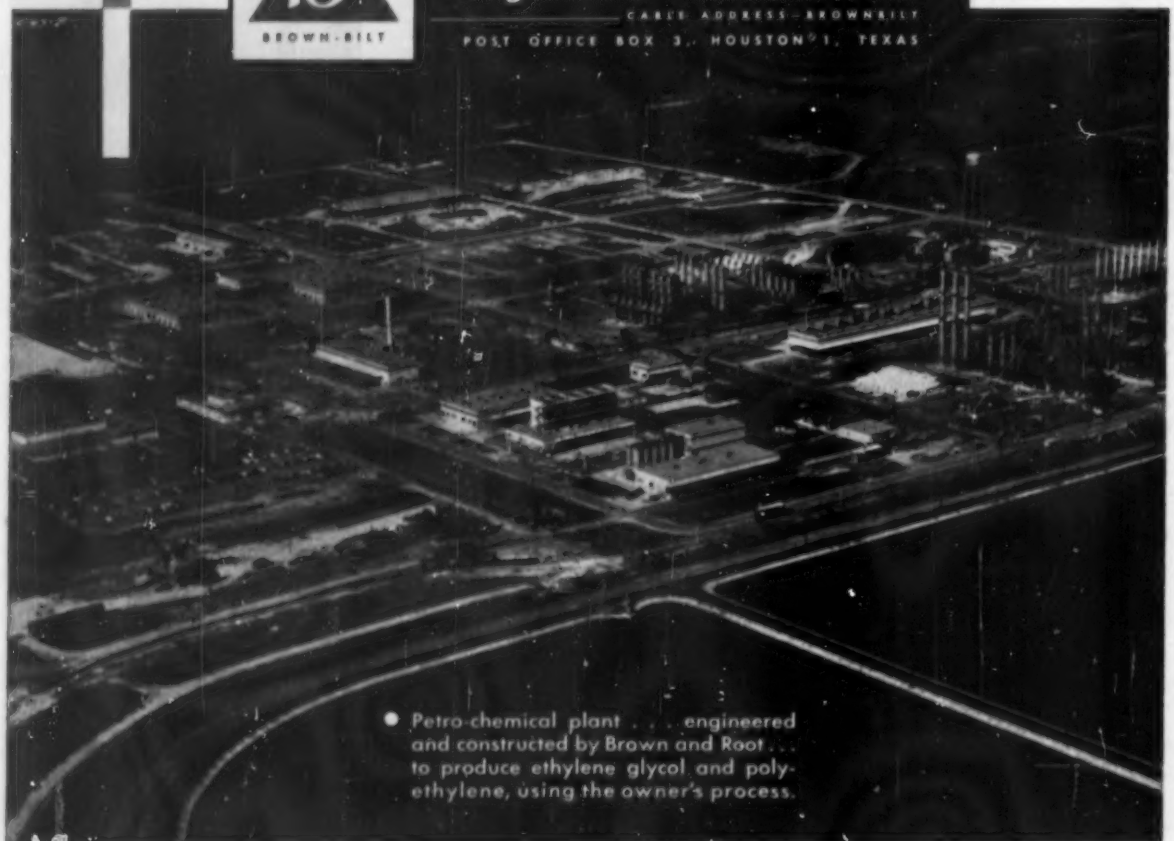

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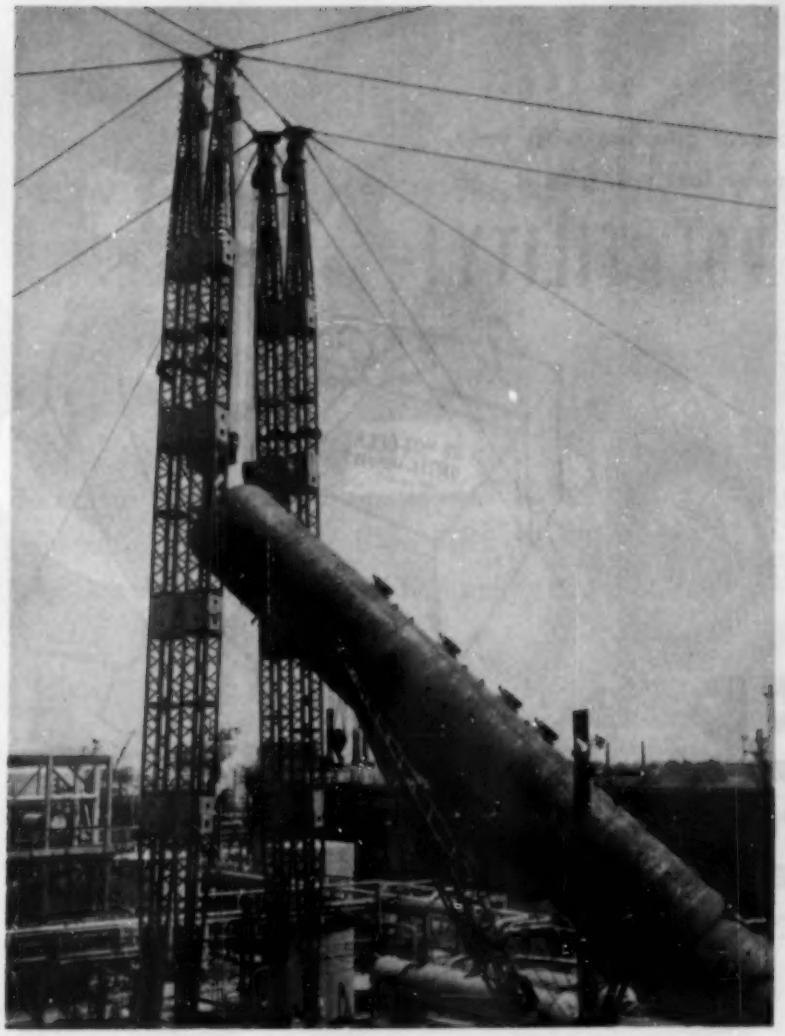

Heavy Deresining Tower Erected—

This picture shows how Humble Oil & Refining Company's new deresining tower, the heaviest of its kind ever erected in one piece, was raised into position at the Baytown, Texas, refinery. The new tower is 94 feet long, 13½ feet in diameter and has steel wall more than three inches thick. Fabricated in Houston, it arrived in Baytown on a special railroad flat-car hookup. Four 140-foot gin poles were used for the raising. It took four days to prepare for the lifting, one day to lift and four days to remove the poles and other equipment.

with 3 cc. TEL from a straight-run naphtha boiling in the range of 206 to 357 F. The Platformate is being used in producing gasoline.

The new unit was designed, engineered and licensed by Universal Oil Products Company, with Procon, Inc., serving as contractor. Other Platformers being built for Gulf are at refineries in Philadelphia, Cincinnati, and Port Arthur, Texas.

Consolidated Chemical Industries, Inc., has put on stream a new sludge acid regeneration unit at its Baytown, Texas, plant. A second unit at Houston will go on stream this month, making a total of five sludge decomposition units operated by Consolidated. The new facilities are expected to eliminate the danger of stream and air pollution.

Empresa Petrolera Fiscal, owned by the Peruvian government, has completed the reconstruction of a small topping plant at Iquitos, on the headwaters of the Amazon River. The plant, with a daily capacity of 1500 barrels, formerly was operated at Zorritos on Peru's northern coast.

The Texas Company has gone into operation with two more Platforming-Unifining units, making a total of six such units recently completed at Texaco refineries. The first of the more recent installations to go on stream was a 20,000-barrel-a-day combination unit at Port Arthur, Texas, where the company completed an almost identical unit last August.

Texaco's sixth such unit, built for a daily capacity of 13,000 barrels, went on steam at the Lawrenceville, Ill., refinery. A straight-run naphtha is being charged to the Unifiner in preparation of feed stock for the Platformer, which is designed to produce a 90 F-1 clear-octane blending compound.

The Port Arthur unit is designed to charge straight-run gasolines to produce a high-octane blending compound. Like its companion facility, the new unit is designed to produce aviation-gasoline base stock.

Union Oil Company of California has gone on steam with the last units of its new 50-ton-a-day coking and sulfur plants at Santa Maria, Calif. This marks the end of the most extensively integrated refinery program undertaken by the company. Started more than four years ago, construction costing $70 million has added facilities to three refineries and built a fourth.

The first phase of Union's program consisted of construction at the Los Angeles refinery of a fluid catalytic-cracking unit and additional crude capacity. In addition, the butane-isomerization plant, shut down since the end of World War II, was rehabilitated.

At the company's Cut Bank refinery in Montana, a catalytic reformer and Unifiner were installed. At Oleum, work included construction of a Platformer, Unifiner, extensive new wharf facilities and other units.

Royalite Products, Ltd., has gone into operation with three new processing units at its recently-completed 5600-barrel-a-day refinery at Kamloops, B. C. The new equipment, installed at a cost of $2.5 million, includes a fluid catalytic cracker, a gas-concentration plant and a polymerization unit.

The cat cracker, designed for a daily capacity of 1420 barrels, is cracking blended atmospheric and vacuum gas oils into high-octane gasoline at a conversion of 65 percent. The unit's design coke burning capacity is 1620 pounds an hour.

Design specifications for the polymerization unit called for the production of 126 barrels a day of 10-pound polymer. By-products of this unit are butane and propane LPG.

Universal Oil Products Company designed and engineered all three units and licensed both the cat cracker and the poly installation. Caribou Engineering Company handled construction.

Conselho Nacional do Petroleo has gone into operation with its new $60-million refinery at Cubatao, Brazil. The plant, completed early this year, has been in operation on a testing basis.

Built for a daily capacity of 45,000 barrels, the plant has been hitting a thruput of 53,000 barrels a day. The Brazilian government agency is studying plants to increase capacity by another 15,000 to 30,000 barrels a day.

Celanese Corporation of America has completed an expansion expected to double the capacity of its vinyl-acetate facilities at Pampa, Texas. The company also is installing facilities at Pampa for the production of methyl ethyl ketone.

For more data on advertised products, use Readers' Service Cards, last page.

Blending WARREN natural gasoline with your present high quality motor fuel will give it

RETAINED VOLATILITY!

Like a summer-time gift from Santa...

THE PEP

STAYS IN THE "PACKAGE"
NOT TO BE RELEASED UNTIL
IT REACHES THE CUSTOMERS' ENGINES . . .

You can depend on Warren's production, transportation, storage and SERVICE for the grade and quantity of NATURAL GASOLINE you need — when and where you want it.

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

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How Annual Reports Are Judged

Your company's most important document yearly should aim at maximum readership. But does it? Here are an expert's views on the good and bad points of reports. Part II.

J. J. Cosgrove, chairman of the board and director of Continental Oil Company, left, receives an "Oscar of Industry" award for the best annual report among major oil companies. Presenting the award is Weston Smith, originator and director of the annual report surveys.

Weston Smith,
"Financial World,"
New York

THE METHODS utilized to rate, screen and finally judge the best annual reports each year may serve as a guide to those who participate in the planning, organization and preparation of the company's most important yearly document: the annual report. First, it must be understood that efforts are not to be directed to winning an award, but rather to gain the greatest readership and understanding among stockholders, the investment community and the public.

In the initial rating of the 5000 annual reports, each is subject to tests in three major categories: (1) Mechanical; (2) Editorial; and (3) Financial Statements.

1. The "Mechanical Test" immediately eliminates all annual reports of less than 12 pages. This, of course, excludes single folders of 4 pages, double folders of 6 pages, and stapled booklets of 8 pages. Reports of less than 12 pages, including cover, often include an adequate president's letter and suitable comparative statistics, but they seldom create a good impression or find any use other than a matter-of-record confirmation of the balance sheet and profit and loss statement certified by the independent auditors.

The next step in the "Mechanical Test" provides for the exclusion of all annual reports of less than 24 pages which are devoid of illustrations such as photographs, pictures, charts or maps.

The final step in the "Mechanical Test" takes care of the annual reports of less than 32 pages which are prepared in poor taste or have an amateurish design. Such reports may include photos and charts, but they are lacking in the kind of format which will make a good impression on the reader if they attract any readership at all.

2. The "Editorial Test" includes a consideration of the cover design (does it imply the nature of the business, provide the year of the report, and name the corporation reporting); a reading of the president's letter and the narrative section, if any, plus a check to see if the names of the officers and directors are listed. A clear discussion of the company's financial status and the trends of operations, plus a review of problems and their proposed solution, are regarded as essential. Whether the report has a table of contents is not regarded as a demerit at this stage.

3. The "Financial Statement Test" has to do with the reporting of the balance sheet, income account and profit and loss statement, plus the auditors' certification. Such figures must be provided for at least two years, and those which also include a five- to ten-year tabulation of operating and financial statistics have a plus factor which may offset another weakness in the report. In the balance sheet, it is required that current assets and current liabilities be reported by totals, and somewhere in the report the net working capital and the working capital ratio for at least two years should be listed.

If the report features a "Highlights Page" giving essential statistics for two years with a percentage change column, this tabulation is regarded as a plus factor and will offset another

dbpc® Antioxidant

does not contribute to manifold deposits

Two popular antioxidants—**dbpc** inhibitor* and a well-known commercial gasoline gum inhibitor — were tested in a blend containing 60% catalytic cracked and 40% thermal cracked gasolines. The manifold test unit employed in the experiment consisted of the specially-designed manifold shown here, attached to a single-cylinder, air-cooled engine, with provisions for control of fuel rate and temperature. The air-fuel mixture from the carburetor entered the manifold which was heated by two 500-watt, pancake electric heaters attached to the manifold exterior. Manifold temperature averaged 255° F. Photographs above show identical sections of the two test manifolds.

Operational tests were made on both antioxidants and the results showed that **dbpc** did not contribute to manifold deposits. (Left photo). On the contrary, it actually tended to *reduce* deposits. Antioxidant "A," on the other hand, *increased* manifold deposits, as shown in the right hand photograph.

In addition to this outstanding feature, **dbpc,** *pound for pound, is the most economical gasoline antioxidant in use today.*

dbpc is also supplied in easy-to-handle liquid form as Impruvol 33® antioxidant. For information write:

*2, 6 di-tert-butyl-para-cresol

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Chemical Division, Dept. PR-65, Pittsburgh 19, Pennsylvania

CHEMICAL PROGRESS WEEK—OCT. 19-25

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As Management Sees It . . .

weakness in the report. Every report rated for a "Merit Award" must provide the capitalization at the year-end, and give earnings and dividends on a per share basis on either the stock outstanding at the end of the year, or on the average number of shares during the year.

In the early days of the *Financial World* competition, an attempt was made to grade each annual report by an absolute percentage of 60, 70, 80 or 90 percent. At that time a rating schedule listing over 100 items was checked, but this time-consuming task proved both impracticable and unscientific. It finally was decided that any rating of annual reports could not be reduced to a percentage basis. In addition, there was the fear that the rating schedule might fall into the hands of a few of the competitors and provide an unfair advantage over those who did not know of the existence of a rating scale.

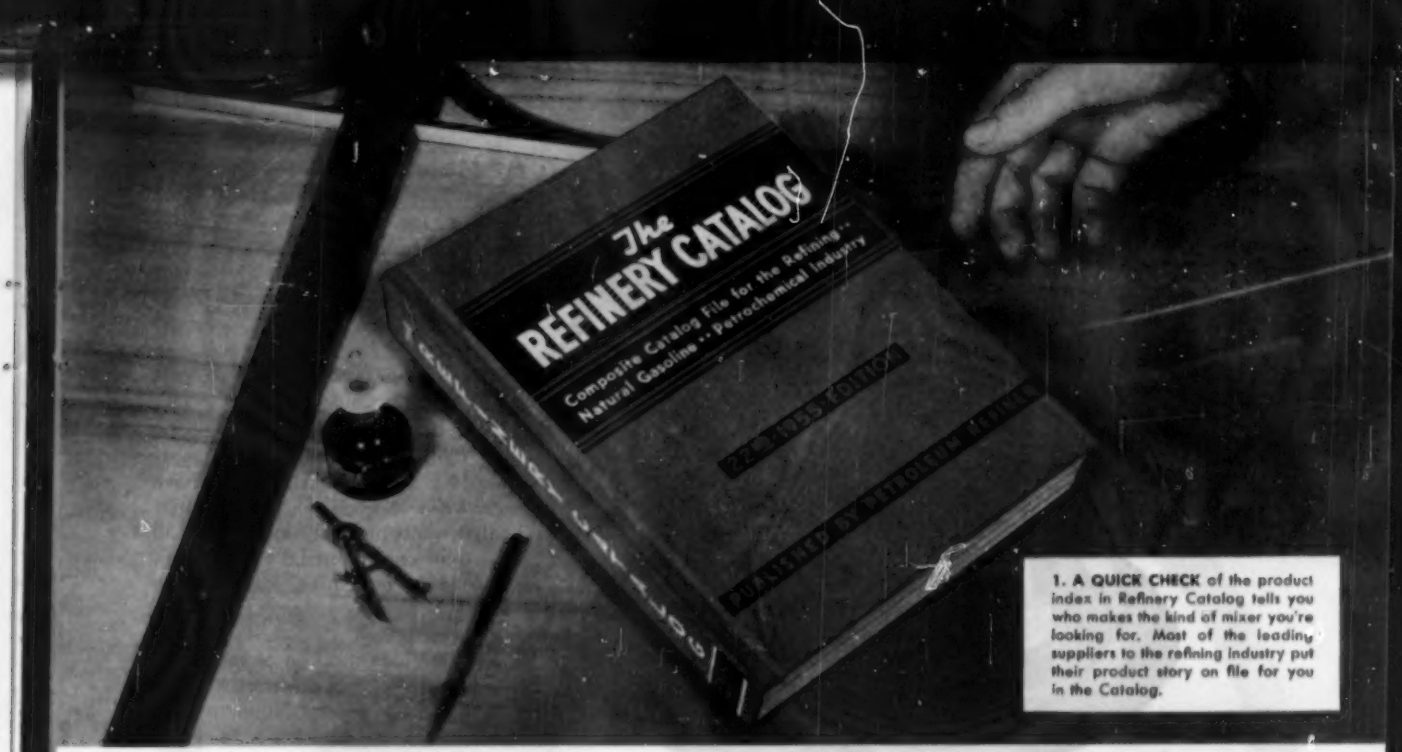
The Ratings—Today, all annual reports are rated "Good," "Fair" or "Poor" which in the terms of an annual report card means a high grade, a passing grade or a failure. The files of *Financial World* have a complete record of the rating on every annual report for each year it has been submitted.

In prior years a citation of "Honorable Mention" was awarded for annual reports rated as "Fair" or receiving a passing grade. This award was discontinued in 1954, as it was discovered that too many companies seemed to be contented to just obtain a passing grade and not make sufficient effort to earn a "Merit Award" and qualify for the final judging. It was felt that any management who could not turn out better than a "fair" annual report after 12 years of the competitions was no longer entitled to any recognition.

The annual reports rated for "Merit Awards" are announced each year in the Annual Report Survey Number, published in the last weekly issue of *Financial World* each June. In this issue each of the Merit-winning reports are listed in one of the 100 industrial classifications where they compete for the bronze "Oscar."

During the months of July and August the 1700 or more Merit-winning reports are reviewed by a Screening Committee of 20 leading members of the New York Society of Security

For more data on advertised products, use Readers' Service Cards, last page.



1. A QUICK CHECK of the product index in Refinery Catalog tells you who makes the kind of mixer you're looking for. Most of the leading suppliers to the refining industry put their product story on file for you in the Catalog.

When you want quick facts on fluid mixing *here's what to do . . .*

You'll find a wealth of helpful facts on fluid mixing in your current copy of The Refinery Catalog.

For example, let's say you're looking for information on a mixer for blending gasoline or lube oil. Here's how easy it is to find what you want.

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Lightnin® Mixers
MIXCO fluid mixing specialists

2. NEXT, FLIP to the catalog data section, where you'll find condensed catalog information prepared by the manufacturer. Here's the LIGHTNIN Mixer catalog unit—16 pages packed with product facts, arranged to help you make a selection quickly.

3. THIS SPREAD on LIGHTNIN Side Entering Mixers gives you a quick idea of how big a tank you can mix, what viscosities, how the mixer is installed, types and materials available, horsepower range, and mounting flange sizes.

4. CUTAWAY SHOWS how LIGHTNIN construction insures permanent alignment of parts, smooth running, easy maintenance. You'll also see picture and description of a new LIGHTNIN rotary seal that eliminates stuffing-box maintenance.

5. AT YOUR FINGERTIPS are the facts on LIGHTNIN Mixers for any type of service. This section, for example, gives you a quick briefing on electric and air driven LIGHTNIN Portable Mixers. Other pages contain information on impeller selection, scale-up, and mixer efficiency.

6. WANT MORE FACTS? Just check name, address, phone of the nearest LIGHTNIN sales representative, and place a call. This page also tells what else you can get in the way of information (including catalogs, technical articles, even a 30-minute color movie on mixing).

7. NO TIME TO WRITE? Then just drop one of these handy cards in the mail to Refinery Catalog. They'll see you get the facts you're after. It's the easy way to start writing a specification. Why don't you try it—whenever you have a fluid mixing job to do?

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Easiest to Use... Threads 1", 1¼", 1½" and 2" pipe and conduit with 1 set of chasers that adjust to size in 10 seconds. Mistake-proof self-centering workholder sets instantly to size. Threader can't jam—it kicks out automatically when standard length thread is cut. Unbeatable speed, least work.

Perfect Threads... 65R cuts beautiful threads—and you find the factory test sample in your new die stock to prove it. No other threader gives you as much for your money.

Ask to see the 65R at your Supply House. Try it, buy it—
it's a bargain in satisfaction.

The Ridge Tool Company • Elyria, Ohio, U. S. A.

RIDGID
Work-Saver Pipe Tools

As Management Sees It . . .

Analysts, Inc. Most of these financial analysts specialize in one or two major industries, while a few are "general practitioners" who are qualified to handle the miscellaneous classifications, and through the process of elimination the best three annual reports in each category are selected.

It is during the screening process that refinements and improvements count for the most. All reports have been rated as good, and the security analyst must now screen ten to 50 reports in one industrial classification down to the best three. Many factors may influence his judgment: a striking cover design, a good "Highlights Page," the identification of the members of the board of directors who are not officers of the corporation, an adequate table of contents; a brief but complete president's letter written for popular understanding; an ample narrative section, suitably sub-headed and appropriately illustrated with well-captioned photographs and easy-to-understand charts.

Some Pitfalls—A well-designed format should have type large enough to read without strain, and this includes the footnotes to the financial statements; reports having the appearance of an advertising brochure or trade catalog are downgraded. Complete financial statements should include comparative balance sheets with reasonable breakdowns in inventories, reserves and the surplus account (it is preferred that "Earned Surplus" be called "Earnings Reinvested in the Business," while "Capital Surplus" be qualified as "Paid-in Capital").

The income account and profit and loss statement is where many otherwise good annual reports fail to reach the top three in their industrial classifications. The best reports should include a reasonable breakdown of the sales dollar, providing when possible the amount of revenues from each division or kind of product—income from subsidiaries (foreign and domestic) should be shown separately, as should income from investments and "Other Income." Operating expenses also should be broken down into such essentials as cost of sales, salaries and wages, advertising expense, etc. Taxes should be denoted as federal, state and local, and net income before and after federal taxes should be clearly

For more data on advertised products, use Readers' Service Cards, last page.

a tight fit is an advantage here

here's how B&W SEAMLESS ALLOY WELDING FITTINGS SAVE SPACE IN A PIPING INSTALLATION

Design for Compactness with B&W Seamless Welding Fittings

Consider these important advantages in making extra plant space available. Note how the elimination of flanges and bolts can simplify the entire structure.

True circularity and uniform wall thickness throughout enables special odd angle cuts to be made when necessary, and still be aligned with the pipe.

Compact piping systems are easily managed through the use of welding fittings. They permit close-nesting in corners, or against walls and ceilings.

The right selection of many possible shapes offers limitless possibilities of piping design to fit almost any space available.

Welding fittings permit simplified design of a piping system. They present a compact, streamlined layout . . . the absence of bolts and flanges allow piping lines to be close-nested, or to hug walls, ceilings or plant equipment.

The joint between fitting and pipe, in welded construction, is virtually flush, with the weld metal forming a solid, tough structure whose strength approaches that of the pipe itself.

B&W SEAMLESS WELDING FITTINGS

GRADES: Carbon, Alloy and Stainless Steels.

TYPES: Elbows, Tees, Caps, Saddles, Laterals, Nipples, Returns, Flanges, Stub Ends, Reducers, Crosses, Bull Plugs.

SIZES: Complete range of sizes and schedules.

IT PAYS TO LOOK AT THE ADVANTAGES OF USING B&W SEAMLESS WELDING FITTINGS

Welded Construction Assures Minimum Pressure Loss—True circularity and radii, uniform wall thickness, and smooth inner walls reduce friction, turbulence and subsequent erosion, adding to piping system life.

Whole Sections Can Be Shop-Fabricated—For fast installation, or where working space is limited, entire sections can be shop-fabricated and installed by any qualified welder in a few minutes.

Welded Construction is Easily Insulated — Insulation is simplified by the absence of complex flanged assemblies. Because joints are leakproof, insulation is permanent and maintenance free.

Welded Construction is Permanent — Maintenance costs are kept at a minimum because piping is permanent and leakproof. The strength of the weld approaches that of the pipe itself.

Welded Construction is Simple to Install—Dimensional accuracy of angles, radii, and bevels, assure quick and easy joining. Any qualified welder can do the job efficiently and economically.

Welded Construction is Lightweight—Strength with lightweight permits easy handling in installation. Unwieldy sections can be joined on the ground, and then quickly fastened into position.

THE *NATURAL* SOURCE FOR ALLOY FITTINGS

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LOOKING FOR AN "ALL PURPOSE" EXPANSION JOINT?

Zallea has never built one—never will. And for good reason. Like all precision engineered equipment, Zallea Expansion Joints are designed to fill specific rigid requirements. In every case, types, sizes and materials of construction are determined by factors of temperature, pressure, traverse and special service conditions.

Zallea Brothers design and build expansion joints for every requirement of modern industry. Field tests have proved the value of our emphasis on designing the expansion joint to fit the problem. Records show that Zallea Expansion Joints outlast all other packless expansion joints from 90% to as much as 1200%. Such reliability is further proof of Zallea design superiority.

Zallea representatives are always ready to help solve problems relating to expansion joints. Or if you prefer, write for Bulletin 351 which describes the many standard types available.

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World's Largest Manufacturers of Expansion Joints

shown both as a total and on a per share basis; it is well for the shareholder to know how much per share goes to Uncle Sam each year.

Finally, the report providing a five- or ten-year tabulation of operating and financial statistics will be regarded as a better annual statement than one which does not; of course, an adequate ten-year table is superior to any kind of a five-year table. In addition, the background statistical tabulations which give the profit margin, the working capital ratio, the book value and other efficiency indices are regarded as better than those which do not.

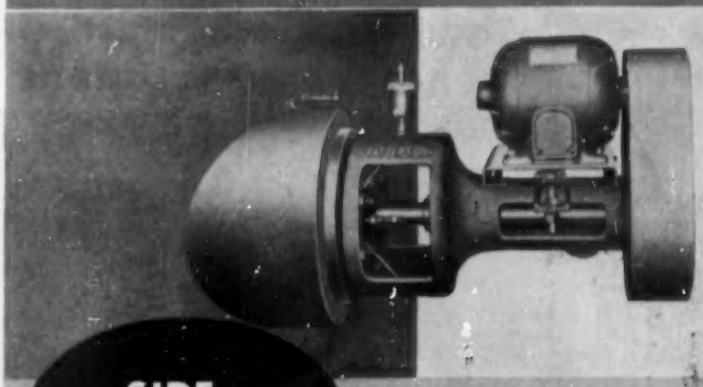
Other incidental statistics which make for a better report include the number of employes (total or average by years) and the plant investment per employe; the number of stockholders (geographical locations, sex and average holdings).

When appropriate, a table can show the retirement of funded debt, bank loans and preferred stock by call or conversion; cash-flow tables or statements showing the source and application of funds and changes in working capital over a period of years; profits should never be reported as a percentage on investment, but only as income after expenses have been deducted from sales.

Every annual report considered by the Screening Committee is subject to a careful review for misstatements of fact, distortions of the truth, exaggerations and discrepancies. Equally important in the down-grading are the "sins of omission," where the management fails to report an important development, condition or problem which has occurred during the previous year. As each security analyst is a specialist in the industrial group of annual reports he screens, he will quickly detect when any report fails to tell the truth.

Annual reports are expected to be a review of the past, but they should also provide some information on which to base a judgment as to the future. Thus, when the president discloses some of the plans for the future, and gives some estimates for the coming year, he is providing a better report than one which does not. It is encouraging that more reports are giving unfilled orders and defense contracts (if any) at the year-end and budgets for new plant and equipment

PATTERSON



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MODERN ENGINEERING LETS YOU REPACK FAST AS UNIT RUNS!

New ease, speed and convenience in service is provided by these unique Patterson mixing units. Used everywhere in gasoline blending, sweetening, colorizing and ethylizing, and in the blending of oils, Patterson Side Entering Mixers are genuine outside-packed units that can be repacked in minutes without stopping operation at any time. Write for details.

Richard L. Conway
President

PATTERSON SPECIALIZED EQUIPMENT
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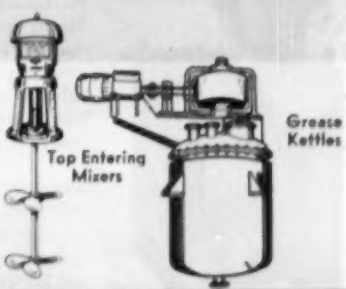
Side Entering Mixers



The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
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The Patterson Foundry and Machine Company, (Canada) Limited
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MONTREAL

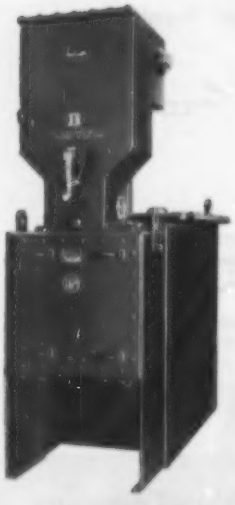
For more data on advertised products, use Readers' Service Cards, last page.

Battery of EC&M Starters in [illegible] refinery.

OIL-IMMERSED

50,000 KVA INTERRUPTING CAPACITY

MOTOR STARTERS BY EC&M



This installation is another example of the increasing acceptance of EC&M oil-immersed Motor Starters by refinery engineers and construction and design companies. The inherent advantages of these starters are high interrupting capacity (50,000 kva or VALIMITOR type for bus of unlimited kva) and assurance of a compact, neat installation.

These slender space-saving starters with self-contained Oil Disconnect Switch require less floor space . . . result in greater area around each unit for inspection and maintenance.

Write for illustrated 16-page Booklet 6062 for full details.

THE ELECTRIC CONTROLLER & MFG. CO.

4498 LEE ROAD • CLEVELAND 28, OHIO

As Management Sees It . . .

expenditures in the new year.

The Judges—By Labor Day each year, the Screening Committee completes its chores and the 300 best annual reports in 100 industrial classifications are turned over to the Independent Board of Judges, which includes the chairman of the Screening Committee, who is the current president of the New York Society of Security Analysts, Inc., and four other top financial specialists. The present chairman of the board of judges is Dr. Pierre R. Bretey, editor of *Analysts Journal* and a past president of the National Federation of Financial Analyst Societies. Other members last year included the president of the Massachusetts Hospital Life Insurance Company, representing the stockholders' viewpoint.

The independent board of judges meets in September to grade the reports, first, second and third in each industrial category. The keynote of the final judging is to find the best in a well-rounded annual report: one that is understandable and serves the requirements of the small investors and at the same time provides sufficient information and detail for the security analyst and the professional investor. The best form of annual report is the one which devotes the front half to the unsophisticated reader, and the back half to experienced financial experts. It is at this point in the judging that extra detail and an abundance of ratios and percentages count for much more than excellence in format, illustrations and typography.

When the judges have completed the selection of the best reports in each of 100 industrial classifications, these winners of the bronze "Oscar-of-Industry" then compete for silver Oscars in six broad industrial groupings: Consumer Goods, Financial Institutions, Industrial Manufacturing, Merchandising & Services, Public Utilities and Transportation (railroads, airlines, buses, ocean shipping, etc.); plus two international awards: Canadian and Latin American.

From the six silver trophy winners, the one gold Oscar winner is selected for the Best-of-All Industry award. The top winner from 5000 annual reports last year was Eastman Kodak Company, and the runner-up, Allied Chemical & Dye Company . . . ##

Where there's refining... there's.. CB&I

Pressure vessels, reactor-regenerators, Hortonspheres®, Hortonspheroids®, Horton® Floating Roofs or other welded steel plate work, fabricated and erected by CB&I are sure to be found where there are refining operations. Chicago Bridge & Iron Company plants are completely equipped to design, fabricate and erect welded steel plate structures to meet the most exacting specifications. Write our nearest office for further information.

UOP reactor-regenerator built by Chicago Bridge & Iron Company for Midland Cooperative Wholesale at Cushing, Oklahoma.

CB&I has been building welded steel plate structures for the petroleum industry for over 65 years.

CB&I

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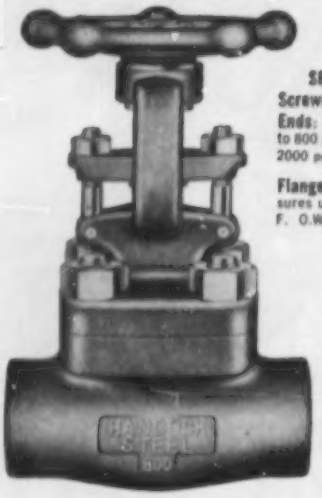
San Francisco • Seattle • Tulsa • Washington
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

For more data on advertised products, use Readers' Service Cards, last page.

LET US
SHOW YOU WHY

Hancock Steel Gate Valves set the pace in dollar-for-dollar service and value

TYPE 950 HANCOCK 800# STEEL GATE VALVES
Outside Screw and Yoke. Sizes: ¼" thru 2"



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Screwed and Socket Weld Ends: For all pressures up to 800 psi. at 775° F. O.W.G. 2000 psi. — 100° F.

Flanged Ends: For all pressures up to 800 psi. at 775° F. O.W.G. 1440 psi.—100°F.

Install a Hancock 800# Bolted Bonnet Steel Gate Valve in your piping system and prove for yourself why this valve sets the pace in dollar-for-dollar service and value. Hancock Gate Valves have cut valve costs in hundreds of refineries, chemical and petrochemical plants and other installations . . . have proved themselves the best, most economical valve for process and power piping systems. They can mean similar savings for you.

To provide such service and value, Hancock Gate Valves combine two big advantages: specially selected materials for extraordinary long wear under difficult operating conditions and an exclusive design for positive, maintenance-free performance. Features include highly accurate guiding to prevent wedge dragging and consequent leaking, a wedge of "500 Brinell" stainless steel, seat of 11-13% chrome stainless steel, plus a spiral-wound gasket and swing bolt and nuts of stainless steel.

When Hancocks go in, valve costs go down.

GET THE WHOLE STORY about these 800# Hancock Steel Gate Valves from your local Industrial Supply Distributor. His knowledge of valves and their correct application can also save you time and money. Phone him today.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, Stratford, Conn. 'CONSOLIDATED' SAFETY RELIEF VALVES, Tulsa, Okla. AIRCRAFT CONTROL PRODUCTS, Danbury, Conn. and Inglewood, Calif. "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, Muskegon, Mich.

As Management Sees It . . .

Supply-Demand Balance Must Be Achieved

Temporary gluts if not checked may cause a long-range famine.

L. F. McCollum, President
Continental Oil Company, Houston

THE LAW of supply and demand and the price mechanisms which go with it are an integral part of the competitive system. It is competition and a free interplay of forces of supply and demand that made the U. S. a great nation. Therefore all should be supporters of this law and opponents of arbitrary controls that would interfere with its operation.

Everyone has to live under the dictates of the law of supply and demand. But it is the task of enlightened management to strive constantly to keep both sides of the equation in balance. If industrial statesmanship is made the basis of policies in the petroleum industry, the law of supply and demand becomes an indispensable ally, furthering the expansion of the industry and increasing the industry's contribution to the well-being of the nation.

To be discussed here are the application of the law of supply and demand to the petroleum industry and the role which management decisions play in keeping both sides of the equation in proper balance.

As regards crude oil, the supply side depends on four main factors.

- Ability to find new reserves.
- The rate at which underground reserves are converted into productive capacity.
- The rate of drawing upon the availability so created in actual production of crude oil.
- Volumes of crude oil imported to supplement domestic supplies.

The extent to which these factors in supply can be influenced by management varies considerably. In exploration, management's opportunities to influence supply are restricted because the risk and success factors cannot be accurately estimated. Different and lesser restrictions exist in producing crude under state conservation laws. But as to imports and refinery operations, management has complete freedom of action. This freedom carries with it a great responsibility.

Management's responsibility is not confined to the supply side of the equation. It also extends to the demand side. Enlightened management can and does stimulate demand for its products. Oil industry management has made available large volumes of petroleum products at reasonable prices. And it has continually stimulated demand through meeting changing consumers' preferences in terms of quantities, qualities and prices.

Specific problems now confronting oil industry management fall into two parts.

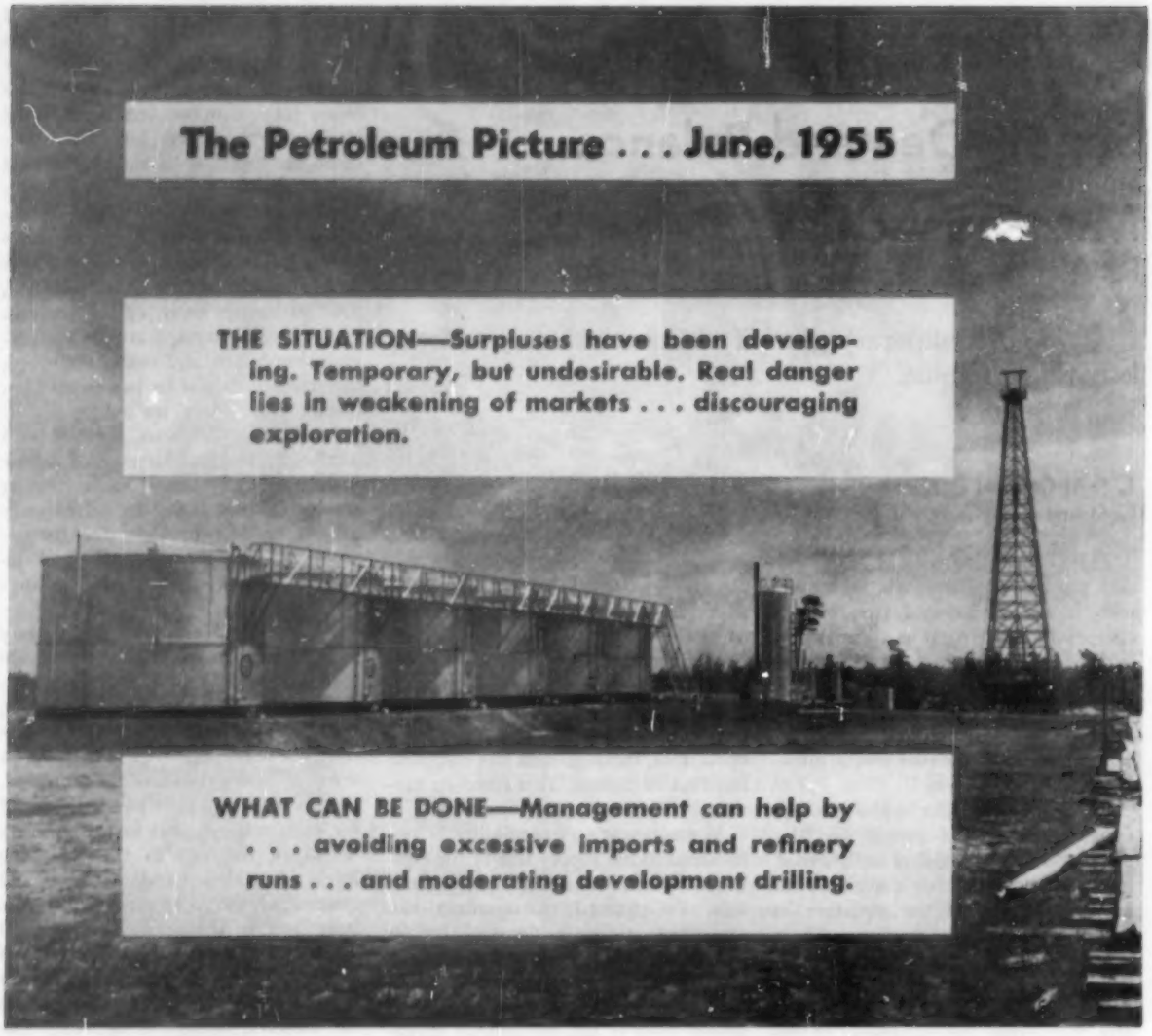
- Those arising from the current situation.
- Those concerned with longer term outlook.

As regards the current situation, the oil industry is affected more than many other industries by seasonal variations in demand. Seasonal swings in demand have become accentuated as more consumers have turned to oil for home heating. The peak in demand for all products is usually reached in January, and the low point almost invariably in May. In 1954, total demand in January was 8,940,000 barrels daily, and in May was only 7,190,000 barrels daily. So, a year ago the seasonal decline in demand over a span of a few months was as much as 1¾ million barrels daily, or 20 percent. Back in the early postwar years, total demand was maintained on a much more even keel, partly because declines in distillate demand were offset by sharp increases in gasoline consumption. In 1946 the shrinkage in demand from the peak to the low point was only 65,000 barrels daily, or 1.2 percent, and in 1947, 339,000 barrels daily, or 5.7 percent. With motor transportation increasingly important and roads improved, the mileage driven by passenger cars, trucks, and busses, no longer fluctuates violently between summer and winter. So, by furnishing the consumer with reasonably priced space heating and propulsion fuels, the oil industry created a new problem for itself—abiding by the law of supply and demand on a short-range as well as long-range basis.

Figures cited apply to the country as a whole. In areas with relatively mild climate, the oil industry's seasonal problem is not quite as acute. But over-all industry figures understate the seasonal swings in demand in areas of heavy distillate consumption. Clearly then, there is an urgent need for each refinery unit in this country to adjust its runs to the shrinking levels of total demand in the second quarter of the year and to increase runs later in the year when demand starts expanding. Similarly, yields of various products need adjustment from time to time to meet changes in the seasonal pattern of demand. The extent of these adjustments will vary by areas, and no uniform formula can be prescribed for the industry as a whole. Appraisal of what adjustments are proper rests with the management of individual units. But whether the aggregate of these individual decisions was right or wrong can be appraised by examining the trends in inventories of two major products, gasoline and distillate.

This year is no exception to conditions described. Total demand for the second quarter is expected to be some 1 million barrels daily below demand in the first quarter. Several oil companies recognized the nature of the seasonal problem and announced that substantial reductions would be made in the level of their refinery runs during the second quarter.

Gasoline inventories turned out to be much too heavy by mid-year in


The Petroleum Picture . . . June, 1955
THE SITUATION—Surpluses have been developing. Temporary, but undesirable. Real danger lies in weakening of markets . . . discouraging exploration.
WHAT CAN BE DONE—Management can help by . . . avoiding excessive imports and refinery runs . . . and moderating development drilling.

1954. This year these inventories accumulated at a faster rate than a year ago. Consequently, gasoline inventories now are definitely on the high side. However, companies in California have been watching the supply-demand situation a little more closely than was the case with the rest of the country, and this is good management.

Excess inventories doubtless will be worked off, as on many previous occasions. We do not have too much oil in this country in the long run. We merely have too much of certain refined products, temporarily. Worry about a temporary oversupply is not justified except for two things:

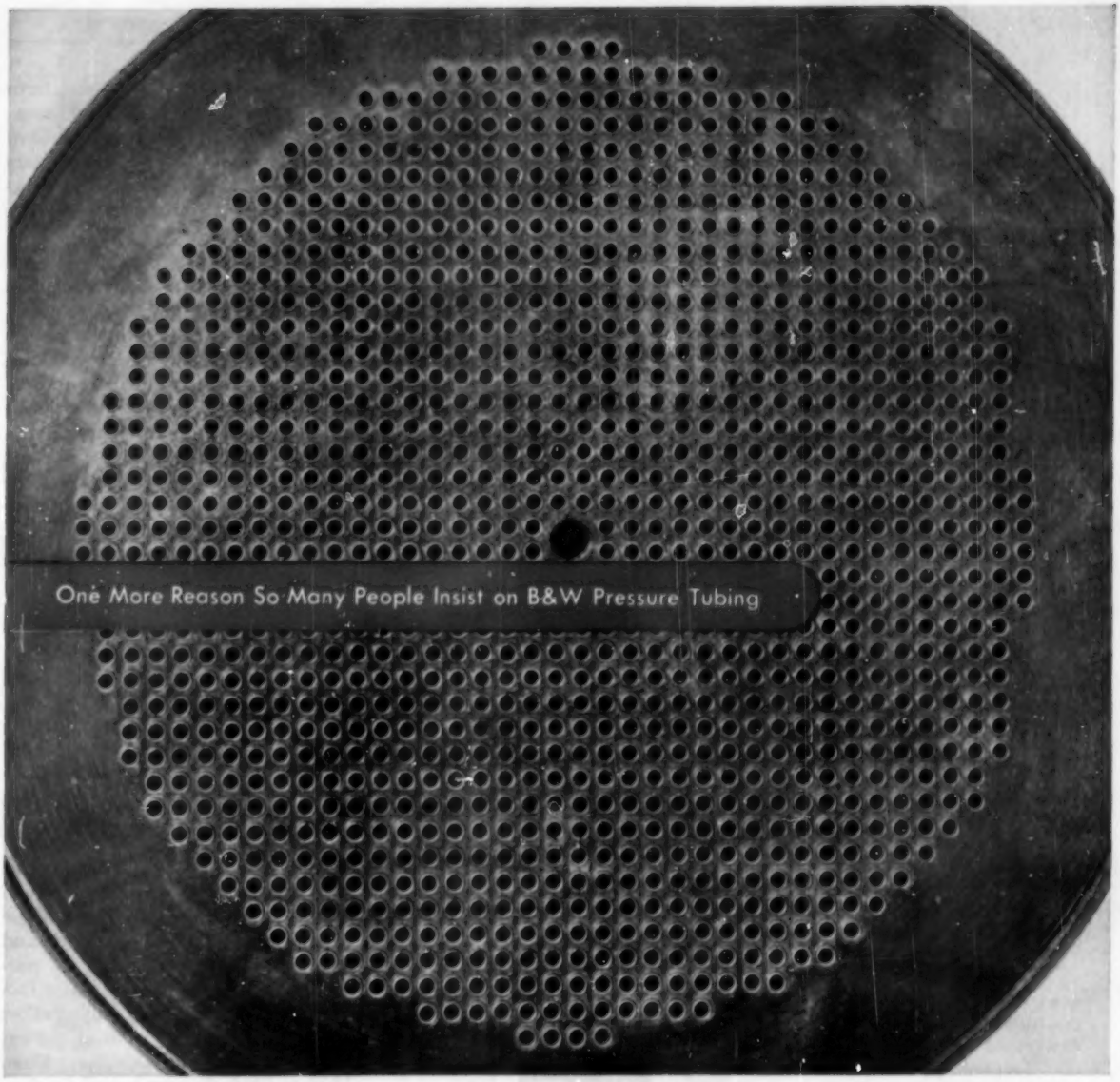
- It can be easily avoided if companies pay more attention to the law of supply and demand.
- If the condition of oversupply becomes protracted, the resultant dislocations in markets for products may seriously affect the industry's ability to find and develop new reserves.

The flow of funds into exploratory and development effort must come from the sale of refined products derived from crude oil. If this flow is materially impaired because products have to be sold on a break-even basis or at a loss, the availability of future supply of oil may be adversely affected.

Longer range trends in supply and demand. In recent years, U. S. crude oil producing capacity and refining capacity have been growing at more rapid rates than demand. As a result, there are now substantial reserve capacities in both production and refining. During the period of 1951-1954, U. S. productive capacity has been increasing at an estimated average annual rate of 6.5 percent, and refining capacity at an average annual rate of 5.3 percent. The average annual increase in total demand during the past four years was 4.4 percent. Creation of reserve capacity in production and refining has been considered vital to national defense and has been encouraged by the government.

It has not been subsidized, since none of the expansion was supported by government funds. A tax policy allowing accelerated depreciation on all or a part of certain petroleum refining and transportation facilities considered vital to national defense has encouraged a greater expansion of

As Management Sees It . . .



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balanced design

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With a Verti-Line, you get sustained, high wire-to-water efficiency, plus wide efficiency spread for "off-peak" conditions . . . Efficiency which results from sound engineering and the highest possible standards of manufacturing quality control.

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More than 100,000 satisfied vertical turbine pump users agree there's no pump like Verti-Line for low first cost, economical operation and negligible maintenance.

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capacity than might otherwise have been undertaken. But no tax incentives in addition to those which have already existed for a number of years were made available to the exploration and production segments of the business.

It looks as if the U. S. has too much productive capacity now, and some people think there may be too much for a protracted period in the future. Is the latter conclusion correct? Examine the trends in underground reserves, from which actual and potential production must come. Has exploratory effort during recent years resulted in additions to reserves large enough to parallel expansion in productive capacity and in demand? Unfortunately, the answer is "no" on both counts.

Reserves versus productive capacity. U. S. productive capacity has grown during the 1951-1954 period at an average rate of 6.5 percent per annum. Reserves have grown at an average rate of only 4.2 percent per annum. The disparity was accentuated in 1954, when the annual rate of growth of reserves declined to 2.8 percent, and growth in productive capacity increased to 7.5 percent. In part, acceleration in rate of growth in current availability of oil was due to secondary recovery projects and technological improvements in production practices. But the major factor was concentration of drilling effort in development type wells at the expense of exploratory drilling. From 1953 to 1954, the number of development wells completed increased by 11.5 percent by contrast, the increase in exploratory drilling was less than 2 percent. In 1954 the industry drilled 3.8 development wells for each exploratory well completed. During the preceding three years, the ratio averaged around 3.1 to 1.

How do U. S. reserves compare with changes in demand? In the last full prewar year, 1940, U. S. reserves of petroleum liquids were 14.3 times as great as the then current demand. In 1946, the ratio declined to 12.1. There was a further decline in subsequent years, and in 1954 the ratio was only 11.7.

Reserves are here purposely related to demand rather than crude oil pro-

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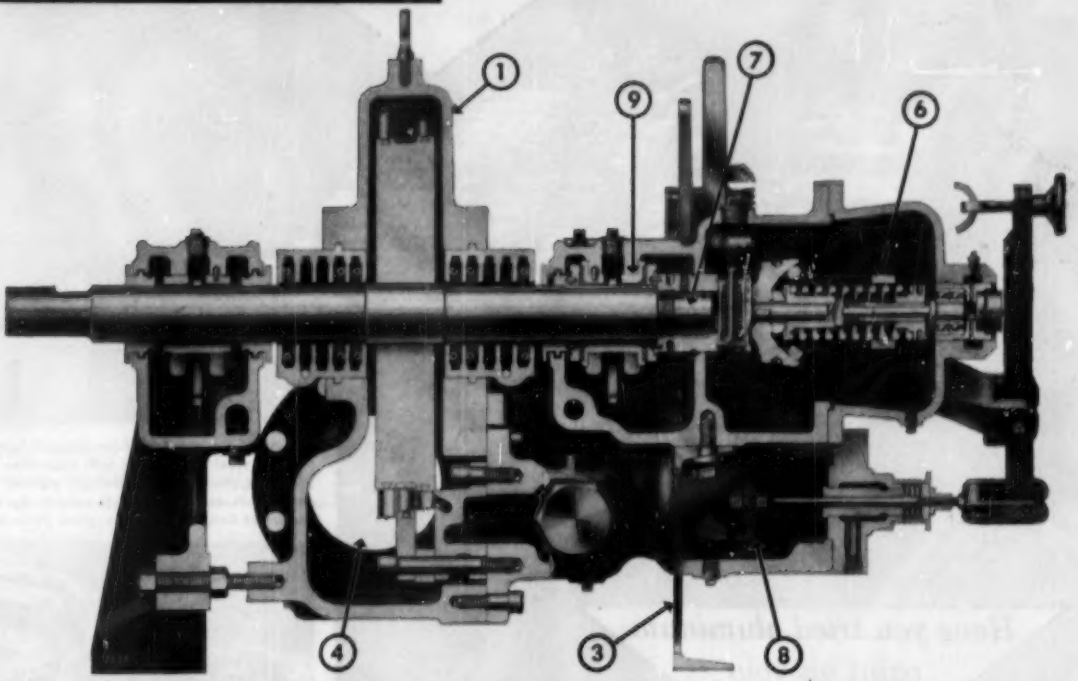

1 Case and Cover Split Horizontally on centerline for ease of maintenance.

2 True Centerline Casing Support assures distortion-free radial expansion. *Not shown.*

3 Flexible Support at governor end provides for axial expansion.

4 Exhaust Opening either right or left side for installation flexibility.

5 Steam Strainer, protecting trip and governor valves, is *removable* for cleaning without breaking steam connections. *Not shown.*

6 Constant Speed Governor features governor weights pivoted around frictionless surfaces.

7 Complete Governor Assembly is now *replaceable as a unit.*

8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.

9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX
Steam Pressure: 300 PSIG MAX
Steam Temperature: 550F MAX
Exhaust Pressure: 25 PSIG MAX
Speed: 4,000 RPM MAX
Steam Inlet: 2"–250# ASA FLG.
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Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle—*at low cost*—a variety of applications in your plant.

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Armstrong Paint & Varnish chooses Aluminum Paint to protect its own tank farm
Have you tried aluminum paint on your tanks?

Armstrong storage tank farm (above) has more than 80 steel tanks, some with capacities up to 25,000 gallons. These aluminum-painted tanks contain oils and other liquids used in the manufacture of Armstrong paints in plant shown below.

The Armstrong Paint & Varnish Works, Chicago, Illinois, with over 100 years of experience in paint formulating and manufacturing, uses aluminum paint to protect its own storage tank farm. Armstrong chose its Armorite aluminum paint from among its many types of maintenance coatings because of aluminum's high heat reflectivity, outstanding protection, excellent durability and attractive appearance.

Armstrong uses its own tank farm as a convenient testing ground. The aluminum paint on thousands of square feet of tank surface is exposed to hot sun, industrial fumes, rainfall, snow and ice and is closely checked by Armstrong technicians for durability and protective characteristics.

Using ALCOA Aluminum Pigments, Armstrong produces several types of aluminum paints including asphalt aluminum coatings and heat-resistant and chrome-finish, all-purpose, aluminum paints.

ALCOA does not make paint, but ALCOA Aluminum Pigments are used in more aluminum paints than any other brand. Special formulas have been developed by paint manufacturers like Armstrong to solve individual problems. Paints made to these formulas actually cost less, last longer, give utmost protection against sun, rain, heat, cold, smoke and fumes.

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Control Work Hazards In Confined Areas

Continued from Page 109

THE PURE OIL COMPANY
FIRE PERMIT

To BILL WEBER Date 3/25 19 55 Time 8 35 AM
The following operation is permitted GRINDING AND WELDING
Location—Limits FRACTIONATING TOWER, LOWER SECTION.
Precautions MAINTAIN ADEQUATE VENTILATION
Gas Tested—Time 8 45 AM Date 3/25 Results SAFE FOR WELDING
Signed C. White
This Permit Expires—Time 4 30 PM Date 3/25
Signed R. B. Parsons Countersigned H. Hollow

FIGURE 5—Welding and burning permit.

neither a toxic nor combustible gas but rather may only be deficient in oxygen. Where there is a deficiency of oxygen and the vessel contains a deposit of iron sulfide and the products of corrosion, auto-ignition will usually occur when the vessel is opened, particularly if forced ventilation is used.

When isolated pieces of process equipment or entire units are taken off stream for maintenance, it is not practical to clear all of the interconnecting lines of product nor to sever the unit from its utilities and other units still operating. This, then, presents the danger of liquid entering the work area through equipment failure or mis-operation.

Where the work is on mechanical equipment and rotative or reciprocating motion is involved, there is the possibility of someone starting the power source without realizing repairs are in progress. The likelihood of this happening is greatest where the starting facilities are remotely located from the machine.

Claustrophobia is defined by Webster as a morbid dread of being in closed rooms or narrow spaces. Some men develop a form of this if, while attempting to enter or leave a vessel, they become lodged, or perhaps while working in a tower their clothing becomes hooked or entangled on protruding parts. This is aggravated if they are excited or believe they are in danger. A few workers who have experienced this say they had the feeling their bodies swelled and movement in any direction was impossible. Thereafter, they are extremely reluctant to accept jobs in confined areas. Claustrophobia is a hazard not as tangible as those already listed but one that cannot be ignored.

Hazard Control—Adequate preparation of any vessel that has contained toxic or flammable liquids which is to be opened for maintenance or inspection is the first step in making the work area safe. This may involve alternate steaming and water washing, the amount dependent upon conditions at hand. In some instances, chemical cleaning has been found effective. Storage tanks should be pumped out, flushed with water, and forced ventilation established. If the tank has contained a leaded product, special precautions must be taken. It is well to follow the directions of the lead supplier.

Closing block valves in product lines leading to or from a vessel or tank is not sufficient protection against possible entry of product. The valves may leak or be opened by mistake. Blanks strong enough to withstand maximum line pressure should be installed under the supervision of operating personnel familiar with the unit. Furnace and boiler fuel lines should be blanked. Where two or more boilers connect to a common steam header and the header remains in service, the main steam valve to the boiler that is shut down should be locked and tagged.

It is well to assume the atmosphere is a combustible and toxic gas in any vessel, pipe or area where hydrocarbons have been processed and treat it as such until it has been proven

Supply-Demand Balance Essential

Continued from preceding page

duction. In preWorld War II days there was not much difference between total demand and domestic production. But since 1946 there has been an increasing gap between the two, caused by rapidly growing imports of foreign crude oil and refined products. In 1946, total imports constituted 8 percent of U. S. crude production and 7.1 percent of total demand. In 1954, imports were equivalent to 16.6 percent of domestic production and 13 percent of total demand. In volume, imports expanded from 377,000 barrels daily in 1946 to 1,052,000 barrels daily in 1954.

Development of new reserves and rapid expansion in production abroad, particularly in the Middle East, had another effect on the domestic situation. Crude oil and products from foreign sources have been backing out U. S. exports of petroleum to an increasing extent. This naturally contributed to a slower rate of growth in total demand.

Two problems have arisen: (1) we have been increasing short-range availability of oil from domestic sources at a more rapid rate than results of exploratory effort justified; and (2) to make matters worse, we have been bringing in foreign oil in quantities which have been generally recognized as being excessive.

The components of the supply side of the equation which have been mentioned, namely the injudicious use of domestic reserve capacity in production and refining and excessive imports, need careful appraisal and watching. They are influenced by management decisions. Oil industry management has done an outstanding job in stimulating demand for its products on a quality and price basis and in discovering new reserves sufficient to meet demand. But the long-range rate of growth in demand may ultimately outdistance ability to find and develop new reserves in the U. S. These reserves are finite and are becoming increasingly difficult to discover. The oil industry therefore must pay particular attention to a proper balance in supply and demand and avoid temporary gluts, realizing that if not checked in time, they may cause a long-range famine.

This is taken from an address before an API meeting in Los Angeles, April, 1955. ##

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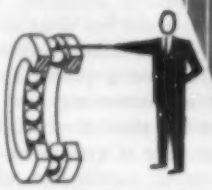
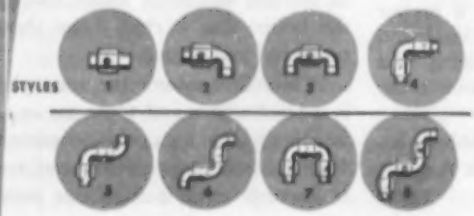


THRUST BEARINGS FOR THRUST LOADS.



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otherwise. Figure 1 shows an explosimeter being used to check a tower prior to entry. This should be done by qualified personnel. A vessel or tank should never be entered until a test for a combustible mixture or a toxic gas has been performed. Before sand blasting, burning, welding or grinding is done, a written permit must be issued by the operating foreman and be countersigned by the craft supervisor, and then only after each has personally inspected the area in question.

Consideration should be given to any hazards that may develop before the permit expires as well as present danger. Figure 5 shows a typical permit. This permit remains with the craftsman and is good for a limited time, so indicated on the permit. After a satisfactory gas test has been obtained and a welding and burning permit issued, an added precaution is to thrust a lighted torch in the manway. This is known as a Fire Test and precludes a possible explosion with men in the tower.

An oxygen deficiency may exist in confined spaces. The first evidence of its effect upon men working in this atmosphere is dizziness, and a ringing sensation in the ears. Welding and burning operations create noxious fumes and smoke. Natural ventilation or chimney effect should not be relied upon to furnish fresh air or carry away fumes. A blower supplying air through a canvas duct or an air eductor may be used. Figure 3 shows a small air eductor. Where adequate ventilation cannot be maintained and vapors are present, hose type masks as those pictured in Figure 2 will allow the work to proceed. Safety lines should be attached if the man is entering a vessel or tank where rescue would otherwise be difficult, if not impossible. If auto-ignition of iron oxide or iron sulfide scale is troublesome, it can be controlled by keeping it wet.

When men are working in a vessel or tank, someone should be stationed at the manway, to assist or secure help in any emergency. As a further precaution a sign, similar to that shown in Figure 4, should be placed at the manway. This should be in position only when the men are actually in the vessel.

When the work is on mechanical

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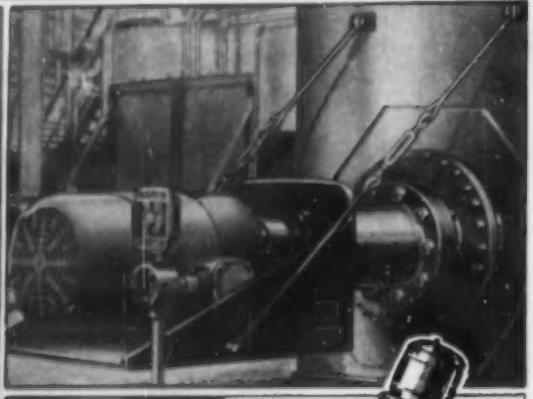

As Management Sees It . . .

equipment, the possibility of the equipment being started without the knowledge of the maintenance man must be guarded against. This is less likely to happen on steam-driven equipment than electrical equipment, although the status of the driver on a piece of steam-driven equipment should be checked before the job is started. The greatest danger is in the repairing of conveyors, shakers, kilns, or rotating machinery. A tag on the starting switch is a minimum precaution. Whenever possible, the main disconnect switch should be made inoperative and tagged.

Equipment and Work Practices—The nature of the refining and petrochemical industry is such that the work often must proceed even if the potential hazard is still present to some degree. This means that tools quite suitable for normal use may present problems when considered for work in confined areas.

Weight and size can be a factor where air-operated tools are used. The control mechanism should be of the non-locking type and preferably spring loaded so that if it is released, the tool will stop automatically. Good footing is not always available. This adds to the difficulty of maintaining complete control of the tool. Care should be taken not to jam the tool when drilling or reaming. Where gas and air supplies are adjacent, attention must be given to making certain the tool is not connected to the gas line rather than the air supply. This has been known to happen with what could have been fatal results.

Electrical equipment must be vapor proof and positively grounded. Power cords should be of the heavy duty type with an oil and chemical resistant cover. Frequent inspection for breaks or deterioration is recommended. Much of the time the surroundings in process vessels will be damp or wet. This proximity of a good ground increases the chance for a severe shock if contact is made with the conductor plus the fact that a man in a confined space may have more than the normal amount of difficulty disengaging himself from the conductor.

Unusual positions and restricted movement increase the fatigue rate

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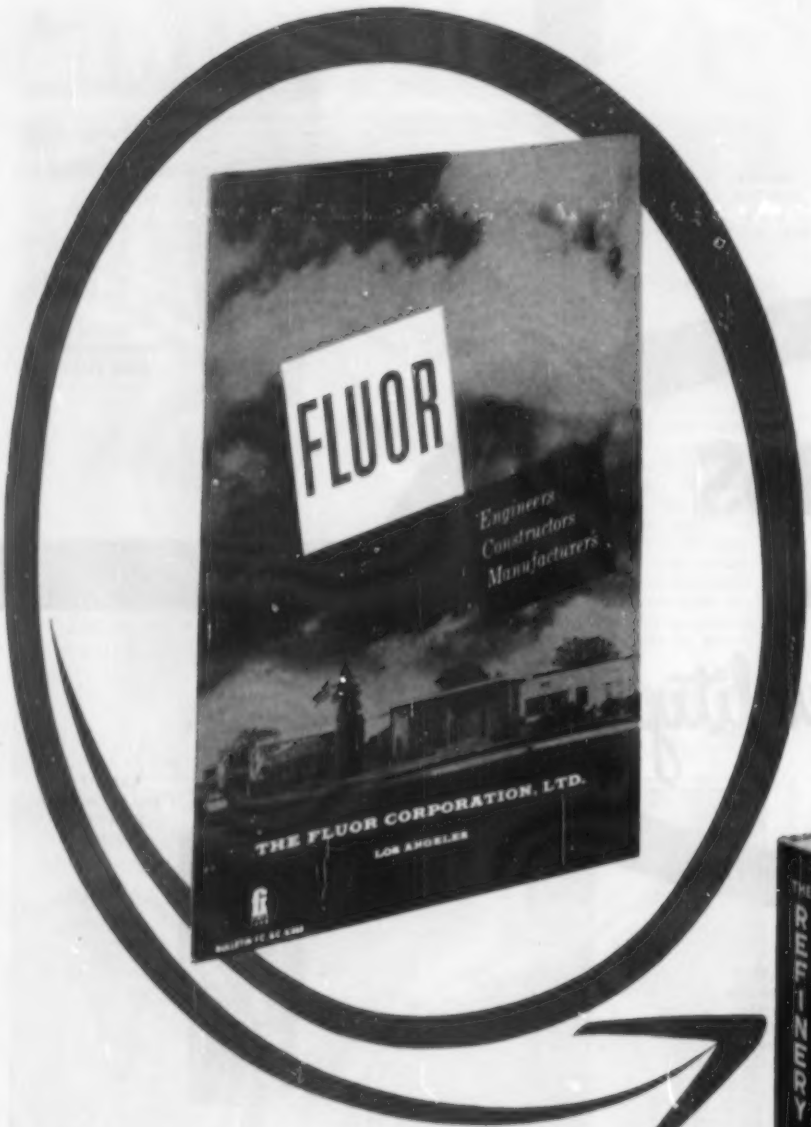

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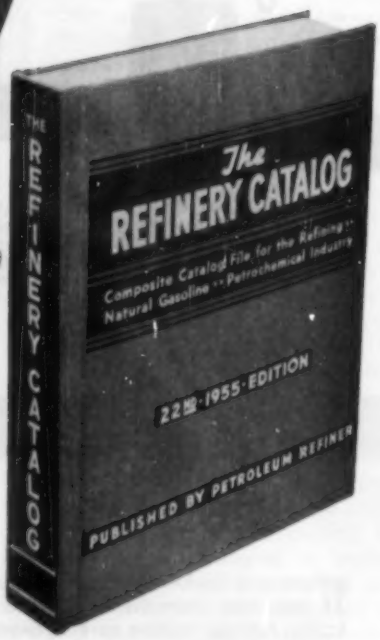
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The REFINERY CATALOG
Composite Catalog File, for the Refining, Natural Gasoline, Petrochemical Industry
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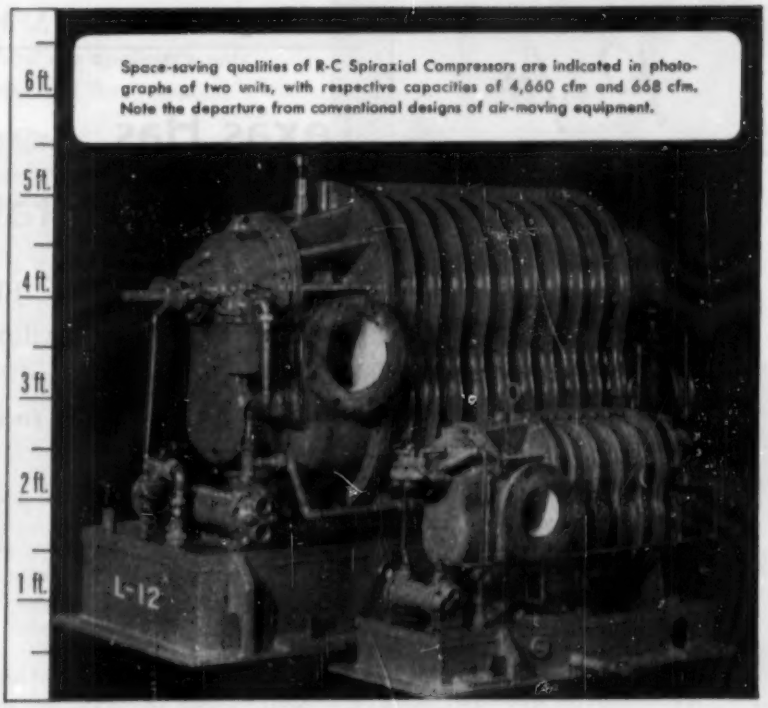
and reduce productivity. Men become more accident prone when they are tired. These are conditions that are determined by the job and little can be done to relieve them, but there are related items which will help to reduce fatigue. Personal safety equipment should offer the least amount of restraint and still give adequate protection. Clean, well fitted goggles and respirators help. Clothing should not be loose or bulky with bulging pockets. Sufficient light that does not glare is important.

When the area cannot be completely freed of combustible gases only non-sparking tools shuld be permitted. These should be kept in good condition, and as a part of the repair procedure they should be checked for imbedded foreign particles, which may cause sparking.

Salamanders are a portable high heat source, but they consume large volumes of oxygen and discharge carbon monoxide, a gas that is odorless, tasteless and toxic if exposure is continuous. They are not suitable for use in a combustible gas area or confined space for these reasons. Where the climatic conditions make supplying heat desirable, electric or kerosine element heaters are used with an auxiliary fan to propel the warm fresh air through a duct. With this arrangement the work area is ventilated and heated.

Housekeeping, or the lack of it, is sometimes a good barometer for determining the quality of the work being performed and to what degree safety practices are being followed. This is true even though specific housekeeping items are only slightly related to the work at hand. Poor maintenance practices with little attention given to establishing safety procedure will seldom be found in a neat, clean work area.

Finally, the control of hazards in confined areas rests with the supervisor. It is his responsibility to recognize and evaluate the hazards, foresee potential danger, and be prepared to take appropriate action. He should know the safety practices that apply to his work and instruct his men in their uses. Too, he is responsible for seeing that safety equipment is used when required and that safe work procedures are followed. ##



Space-saving qualities of R-C Spiraxial Compressors are indicated in photographs of two units, with respective capacities of 4,660 cfm and 668 cfm. Note the departure from conventional designs of air-moving equipment.

For intermediate pressures . . .

SEE R-C SPIRAXIAL® COMPRESSORS

Check these values of R-C Spiraxials before buying any equipment

1. **No internal lubrication —hence oil-free air.**
2. **Internal compression assures peak efficiencies at required pressures.**
3. **Direct connected for speeds of 1750 rpm and 3550 rpm.**
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Before deciding on any air-handling equipment, see the new developments in R-C Spiraxial Compressors.

The amazing efficiency and economy of this latest Roots-Connersville development in air-handling equipment have been proved in continuing orders and installations.

Bridging the gap between the R-C *dual-ability* lines of Centrifugals and Rotary Positives, Spiraxials provide a capacity range from 700 cfm to 5,000 cfm, with pressures from 15 psi to 30 psi. Either single-stage, or multi-stage installations for higher volumes, are completely satisfactory.

For new projects, we suggest a study of these newest Spiraxials. Or, it may well be that they will soon pay for themselves as replacements for present less efficient equipment. Ask for performance curves, and details in Bulletin SC-354.

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As Management Sees It . . .

Texas Has New Labor Statutes

Biennial legislature passes new laws dealing with labor, unemployment compensation and other subjects of great concern to industry.

LAWS ON LABOR, unemployment compensation and other topics of major concern to the oil industry were adopted by the Texas Legislature which wound up a prolonged session at Austin early this month.

Spending. Legislators wrote the biggest spending bill in Texas history. The total for two years will be more than $1525 million. This is $116 million more than the state government cost for the 1953-1955 period. Increases went mostly for education, the result of increasing enrollment.

The state needed about $60 million of new taxes to pay these expenses, not counting the highway program. The remainder of the $116 million increase will come from existing sources.

Labor. The Legislature passed two labor control bills by Sen. George Parkhouse of Dallas, over the vigorous protest of union leaders.

The biggest blowoff came on Senate Bill 45, the so-called "anti-coercion law." Gov. Shivers recommended the legislation in his first message to the Legislature, and he stirred the House into approving it with a message in May when it appeared the bill had bogged down.

The anti-coercion bill outlaws strikes and picketing unless a majority of employes at the place show they favor union representation. The Parkhouse bill would let the district court supervise the election, which would be held within 20 days after the lawsuit is filed.

The presiding judge can call a judge from outside the county to handle the case. This is intended to get away from local political pressure.

Mass picketing. The other Parkhouse bill would extend the venue statute on injunction cases filed under other Texas labor laws, like those against mass picketing. It would allow filing in the county of the alleged violation, in the home county of any defendant, or in Travis county—if the Attorney General takes an active role.

Compensation. Efforts to pass a new workmen's compensation law were defeated. Members agreed generally that the maximum payment to the totally-disabled should be increased; but they disagreed on how much to pay the partially-disabled and on such points as allowances for attorney fees.

'Waste' Bill. One of the session's biggest struggles concerned efforts to pass an "economic waste" statute to let the Railroad Commission prescribe minimum prices for natural gas in the field. The measure, opposed by major purchasers of gas, was effectively bottled up in the House for almost five months.

Spokesmen for the chemical industry were among those opposing the bill. This group also resisted successfully efforts in both House and Senate to put a tax on chemicals.

Unemployment. A new Unemployment Compensation Act became law. It permits Texans to take advantage of a liberalized federal law. Coverage was extended to all employers of four or more persons, formerly eight or more. Employers also can qualify quicker for a rate reduction based on

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TUBE-TURN

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NEW!

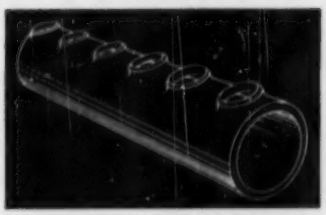
TUBE-TURN Manifold Welding Fitting

simplifies piping construction, reduces costs

TUBE TURNS now offers custom-made Manifold Welding Fittings with size, wall thickness, and number of outlets as required by your service conditions. These manifold fittings are available in all commercial metals and alloys.

Use of TUBE-TURN* Manifold Welding Fittings provides stronger and safer outlet connections than are possible when pads and saddles are employed. This new fitting makes possible greater economy and speed of construction in many types of service. It is particularly useful when outlets are smaller than one-half the run pipe diameter, when they are extremely close together, or when they must vary in size.

This new addition to Tube Turns' line enables you to "specify TUBE-TURN" for all your tee and manifold fitting requirements. For prompt, helpful service, get in touch with your Tube Turns' Distributor. You'll find one in every principal city.



The new TUBE-TURN Manifold Welding Fitting . . . superior to pad and saddle construction . . . easy to install . . . dependable in service.

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.
They meet *all* U. S. piping code specifications

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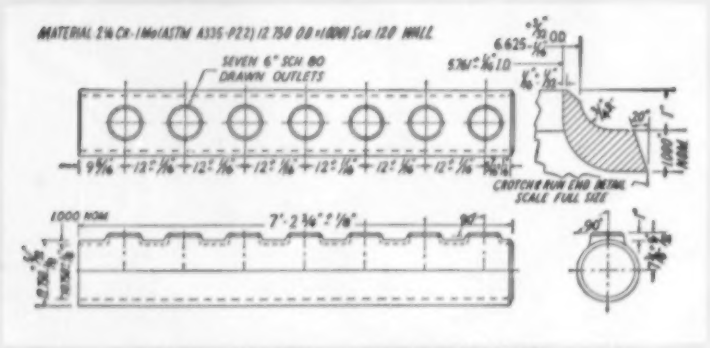
APPLICATIONS

Why TUBE-TURN Manifold Welding Fittings give you safer service

In conventional pad and saddle construction, the transition to the side section of the branch is abrupt, creating stress concentration, often leading to failure. The TUBE-TURN* Manifold Welding Fitting with *integral extruded outlets,* is superior in strength. It provides a smooth transition from the pipe run to the smaller, thinner-walled outlets, and is thus better able to withstand cyclic stress from pressure or temperature changes.



12" Manifold with Seven 6" Outlets. Schedule 80.

TUBE-TURN Manifold Welding Fitting being installed in a measuring station of a large west coast gas utility.

CODE APPROVED

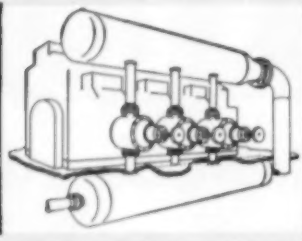
TUBE-TURN Manifold Welding Fittings are in full accordance with the latest recommendations of ASA B31.1 Subcommittee No. 8.

TUBE-TURN Manifold Welding Fittings comply with the requirements of ASA B16.9 and ASTM A234 covering the design and manufacture of butt welding fittings.

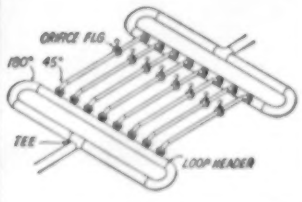
TYPICAL APPLICATIONS

TUBE-TURN Manifold Welding Fittings can be used in virtually all types of major piping systems. Tube Turns' Sales Development Department will be glad to assist you in application problems.

Pipe Still or Charge Heater



Compressor Station Suction and Discharge Headers



Meter Run Loop Header

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favorable experience rating.

Apparently headed for final approval was a bill by Parkhouse to ban unemployment compensation payments where the applicant is idled by a strike of fellow-unionists at another plant. This is aimed at situations like that which arose when Dallas Ford assembly plant workers were thrown out of work by a Michigan strike of parts-makers.

A dispute raged over the wording of a provision to permit unemployment payments where the idleness results through no fault of the applicant. The bill is aimed at situations where the applicant for unemployment aid belongs to the same union as the strikers, and is helping maintain the strike with union funds.

Trucking. A new trucking law raises from 45 to 50 feet the permissible length of truck-trailer combinations; and another increases all motor vehicle operators licenses by 50 cents a year or $1 for each two years. With the funds received from the license increase, the Department of Public Safety plans to hire another 200 highway patrolmen.

Salaries. The Legislature also approved higher salaries for most top state officials and those in the "junior executive" rank who often found pay more attractive in private industry. The three Railroad Commissioners will be paid $17,500 a year each, compared to the present $10,600. The Chief Engineer, Oil and Gas Division, will receive $12,500 a year, a $2000 raise.

Increased pay is expected to help influence William J. Murray Jr., Railroad Commission chairman, to seek a new term when his present term expires after 1956.

Legal. Three major legal codes were written at the session. A new probate code includes, among other things, a long-sought clarification of mineral lease rights involving guardians.

A new corporation code, designed to encourage incorporation in Texas, permits a firm to be organized for multiple purposes. The old law confined a corporation to one purpose.

##

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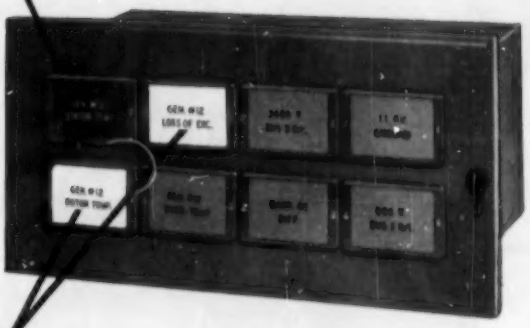
VISUAL SEQUENCE ANNUNCIATOR*

1 VISUALLY INDICATES
first "off-normal" and subsequent "off-normals".



2 SEQUENTIALLY GROUPS
related variables for easy interpretation.

Troubleshooting in complex processes can be expensive and time consuming. The Panalarm "50VS" Visual Sequence Annunciator *eliminates guesswork . . . pinpoints trouble.* It immediately flashes the cause of trouble; instantly shows resultant "off-normals", and provides a means of grouping and acknowledging related variables so that minimum interpretation is required . . . quick, direct corrective action can be immediately taken.

Your present Universal Panalarm "50" Annunciator System can be changed to provide visual sequence signals. This flexibility prevents obsolescence . . . has made the Panalarm "50" the most versatile audio-visual annunciator available today.

PANALARM "50VS" gives CONTROL INFORMATION

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- Secondary "off-normals" resulting . . .
- Sequential follow-up of "off-normal" . . .

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It's best to compare before

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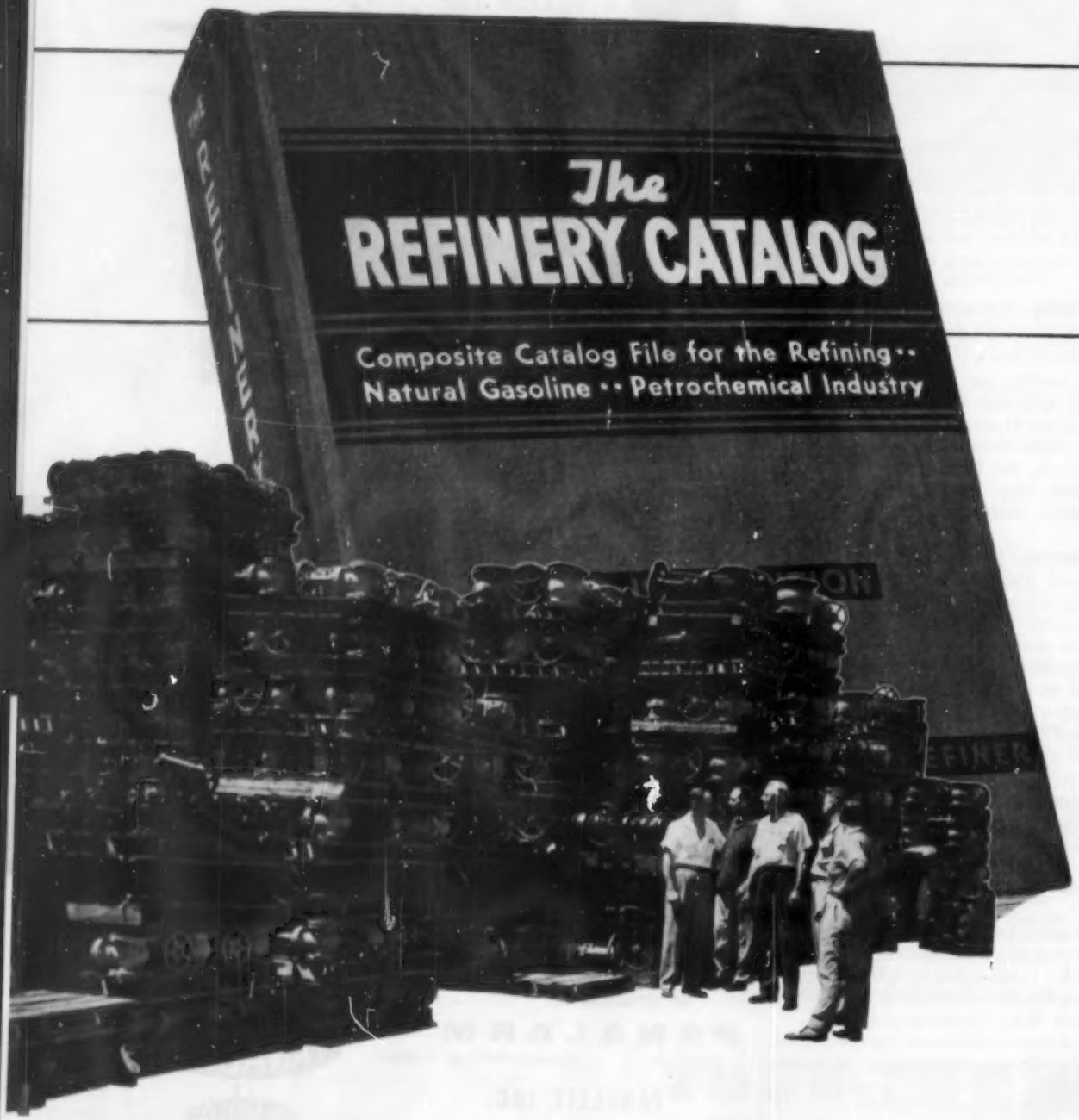

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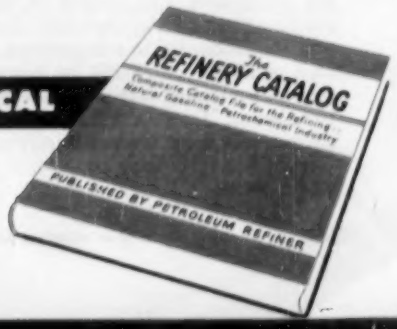

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AND REDUCE DOWN-TIME...

ESSO installs 7,956 Anaconda Cupro Nickel, 30%-702 Tubes in condensers and coolers at Bayway Refinery

This condenser is used in the No. 1 Fluid Catalytic Cracking Unit at the Bayway Refinery of Esso Standard Oil Company at Linden, N. J. The unit produces about 25,000 barrels of petroleum products daily—ranging from high octane gasoline to heating oils.

7,956 ¾" Cupro Nickel, 30%-702 Tubes were supplied by Anaconda for the condensers and coolers of this cracking unit. On the shell side, these tubes are subjected to temperatures as high as 550°F at 75 PSI by process streams containing both sulfur and salt compounds. On the tube side, the summer salt water temperature ranges from 80°F at the inlet to 110°F at the outlet.

Information gathered from test runs within the refinery indicates these ANACONDA Cupro Nickel, 30%-702 Tubes have a life expectancy in this service of from 6 to 12 times greater than tubes made of Admiralty Alloy.

ANACONDA Cupro Nickel, 30%-702 Tubes are recommended where process liquids, vapors and cooling waters are corrosive—particularly where temperatures are too high for other copper alloys. Tubes of this alloy also have superior resistance to sea water at high velocities. They have good physical properties at elevated temperatures and resist stress-corrosion cracking.

Our files bulge with a collection of tube performance case histories that can answer many of the corrosion problems you face. We can put the information in these files to work for you at once—to help you select the one best alloy for your job. Write, outlining your operating conditions, to Dept. TD, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass, Ltd., New Toronto, Ont. 6111

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What's Happening . . .

. . . in the Industry

Fast Write-Offs Granted For 1,873,000 Barrels Since Program Started

Office of Oil & Gas reported that as of April 1, rapid tax write-off certificates had been issued for 1,873,000 barrels a day of basic refining capacity since the program was started late in 1950. Certificates granted during that period also covered the following facilities:

Alkylation; 114,000 barrels a day; aromatics, 55,000 barrels; lube oil, 9000 barrels; lube-oil additives, 11,000 barrels; petrochemicals, 44,000 barrels; natural-gas processing, 312,000 barrels; wet-gas gathering, 22,000 barrels; natural-gasoline storage, including underground facilities, 5,432,000 barrels, and crude and products storage, 120,107,000 barrels.

Nine U. S. Oil Companies Join Iranian Consortium

Nine more U. S. oil companies have acquired interests in production, refining and export rights in Iran, thus extending participation in the Iranian consortium established last October. Interests had been acquired earlier by five U. S. and three European companies.

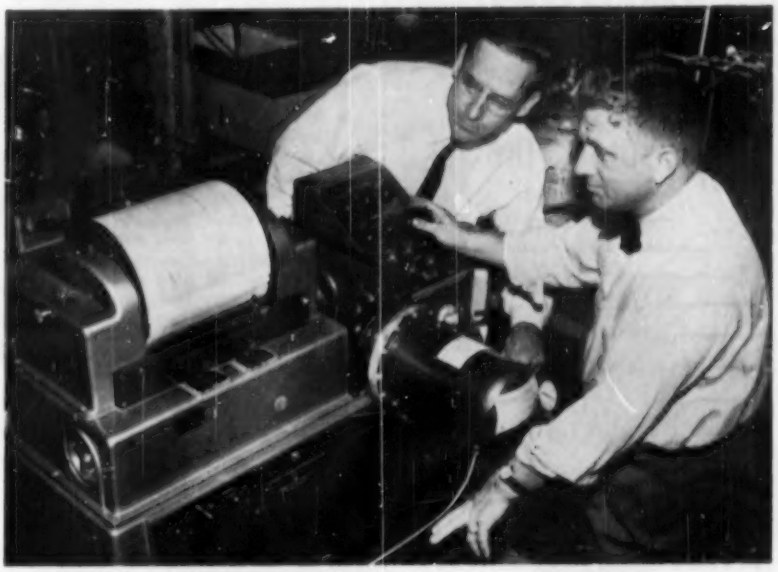
The new companies, which formed Iricon Agency, Inc., to represent them in the management of producing and refining operations in Iran, have an aggregate 5 percent interest in the consortium.

They are American Independent Oil Company, The Atlantic Refining Company, Hancock Oil Company, Richfield Oil Corporation, San Jacinto Petroleum Corporation, Signal Oil & Gas Company, The Standard Oil Company (Ohio), Tide Water Associated Oil Company and Pacific Western Oil Corporation.

The new participation was described by Richard S. Stewart, president of the new agency and vice president of Standard (Ohio), as in accordance with the President's policy of international trade cooperation. Elected as vice presidents of the agency are David Hecht, Pacific Western; Garth Young, Signal Oil & Gas, and B. O. Schmidt, San Jacinto Petroleum.

Delhi-Taylor to Furnish Products for Tide Water

Delhi-Taylor Oil Company will help supply Tide Water Associated Oil Company with products until Tide Water completes its 130,000-barrel-a-day refinery at Delaware City, Del. Tide Water will furnish approximately 10,000 barrels of crude a day, receiving a similar amount of products at Delhi's refinery in Corpus Christi, Texas.



New Smog-Fighting Machine—

The latest weapon in Los Angeles' battle against smog is an adaptation of the hydrocarbon recorder, just developed under the auspices of the Air Pollution Foundation. The adapted recorder sucks in smoggy air, with the aid of a specially-modified compressor using silicone oil, and measures the air's hydrocarbon content. Special filters take out the water content, carbon dioxide and miscellaneous dirt and dust.

According to Dr. Lewis H. Rogers (left), the foundation's senior chemist, the device provides a means of checking the effectiveness of controls over gasoline and exhaust vapors. Nicholas A. Renzetti, senior physicist for the foundation, inspects the device with Dr. Rogers.

Institute Sees No Easy Way To Eliminate Menace of Smog

The oil industry's contribution to smog in Los Angeles has been estimated at 18 percent by Dr. Lauren B. Hitchcock, president of the Air Pollution Foundation. He has said that the industry is emitting 600 tons of pollution in to the air daily, as part of a 3300-ton total.

The balance of the pollution, according to Dr. Hitchcock, comes 45 percent from vehicle operation, 20 percent from domestic use of natural gas and incinerators, 10 percent from miscellaneous industry, and 7 percent from evaporation at service stations and gasoline losses in automobiles.

Another pollution expert, Dr. W. E. Faith, vice president of the foundation, has cited 10 "unknowns" to be explored before Los Angeles can begin to conquer smog. His remarks came in a warning that nothing approaching a solution to the menace can be expected either this year or next.

"Possibilities of controlling smog have been so oversimplified in the minds of many people that millions of residents of the Los Angeles basin have been led to expect quick and easy victory," said Dr. Faith. "Such great expectations definitely are not warranted in the light of current knowledge.

"Our team of researchers, working with other research agencies and individual scientists, has made important strides in licking the smog problem by assisting in developing a whole series of new 'tools', but these adaptations and inventions do not spell the end of smog. I cannot see any very appreciable reduction in smog in sight this summer or next.

"This does not lessen the need for control measures against all known sources of air pollution. We must not wait for research in order to curtail all known smog-formers and pursue all emergency or interim forms of smog reduction."

Dr. Faith listed the following questions that have to be answered before smog can be reduced:

- Do certain hydrocarbons and nitrogen oxides change in the presence of sunlight to produce an eye irritant? If so,

Aromatics Recovery

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SO_2

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Efficient—Economical

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Liquid Sulfur Dioxide has proven itself as the efficient and economical solvent for the recovery of aromatics. It is completely miscible with aromatic hydrocarbons over a wide temperature range, while the solubility of naptnene and paraffin hydrocarbons is limited and decreases with decreasing temperature. Recovery of a higher percentage is obtained.

Tennessee's high quality Liquid Sulfur Dioxide can be effectively and economically applied to your operation. We would like the privilege of discussing this with you.

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What's Happening. . .

are some members of the hydrocarbon family more to blame than others?

- Does the smoke or gases from incinerators contribute to eye irritation?
- Do industrial fumes or smoke cause or contribute to irritation of the eyes? If so, which specific gases or pollutants?
- Do any of these gases reduce visibility, even though invisible as emitted?
- What are the actual plant damaging substances in the air?
- What are the actual eye irritants in the air?
- Are there any compounds yet unmeasured in the air which are responsible for smog?
- Are there any "unknowns" which up to now are not even suspect?
- Are any temporary procedures ready which can be used to control smog on a short-term basis while permanent control methods are being developed? What would be the economic consequences of adopting any such a method?
- How can the hydrocarbon and nitrogen oxide content of auto exhaust be controlled?

Changes Company Name

The name of The American Oil Company's manufacturing subsidiary in Texas, Pan-American Refining Corporation, has been changed to The American Oil Company, a Texas corporation.

Kerr-McGee Organizes Refining Subsidiary

Kerr-McGee Oil Industries, Inc., is setting up a wholly-owned subsidiary to operate all its refining facilities, including those recently acquired from Deep Rock Oil Corporation. The subsidiary, to be known as Deep Rock Oil Company, also will handle the company's marketing and pipeline operations.

With headquarters in Tulsa, the new company will operate two Oklahoma refineries. Kerr-McGee's recently-modernized plant at Wynnewood processes 15,000 barrels a day, while the former Deep Rock unit at Cushing has a daily output of 19,000 barrels. A new name will be selected for the former Deep Rock Oil Corporation from which Kerr-McGee purchased $17 million worth of assets.

Underground Storage Of Natural Gas Increases

The volume of natural gas in underground storage in the U. S. last year was 1 trillion 11 billion cubic feet, according to a report issued by American Gas Association. This represents an increase of 125 billion cubic feet over 1953. Volume of gas in storage has risen to 2.45 times the 412 billion C feet in storage in 1950.

The ultimate capacity of U. S. underground storage reservoirs, including all native and cushion gas in the reservoirs, at the end of the association's year, October 31, 1954, was 1 trillion, 859 billion C feet, an increase of 125 billion over the previous

The Chemistry of Petrochemical Reactions

By LEWIS F. HATCH, Ph.D.

Professor of Chemistry, University of Texas

This 192-page, completely indexed volume is the only thorough and exhaustive treatise on the basic chemistry of reactions and processing of those products and intermediates popularly classified as petrochemicals.

A completely contemporary study, this book is an immediate and valuable reference for anyone engaged in either the chemical or refining industry.

In addition to the technical data, valuable commentaries on end use and market of many significant chemicals are presented in such manner as to make this book a practical working manual.

This new book is a complete presentation of the material originally published as an 18-part series in *Petroleum Refiner*. Revised to date by Dr. Hatch, these current and authoritative studies on petrochemicals are now indexed for easy reference by subjects or products.

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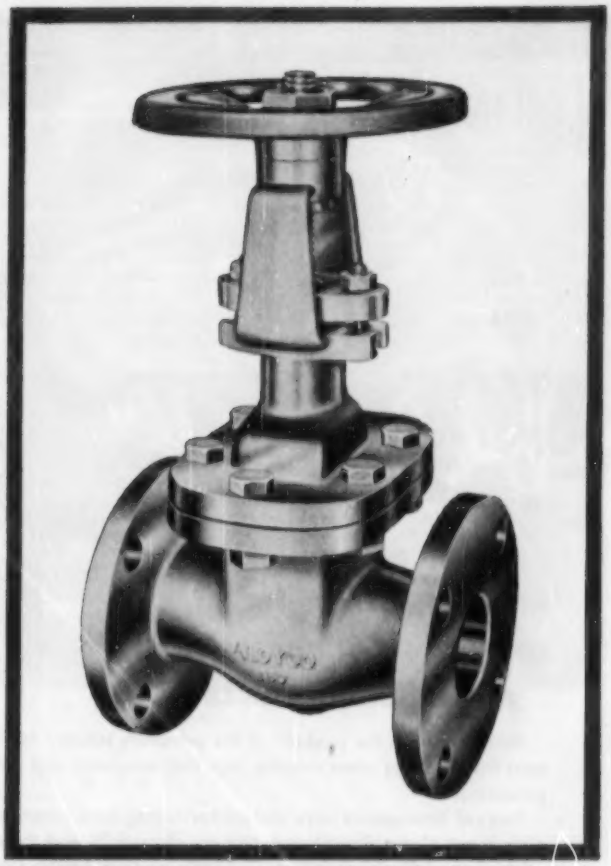
Are your valves over their heads in corrosive reducing solutions?

Switch to Aloyco Monel or Nickel Valves!



ALOYCO MONEL VALVES are used extensively in handling alkalies, salt waters, food products, organic substances, and many air-free acids.

Keeping corrosive solutions of mineral and organic acids, alkalies and salts under control is a job for Aloyco Monel or Nickel valves.

Monel valves are especially good for handling hydrofluoric acid which is used as a catalyst in one process for the production of high octane gasoline. Monel and Nickel have exceptional resistance to neutral and alkaline salt solutions, including chlorides, carbonates, sulfates, nitrates and others. Nickel is more resistant than Monel to more concentrated NaOH solutions at elevated temperatures and is usually preferred when contamination of the caustic with copper or iron would be objectionable.

Nickel, although similar to Monel in corrosion resistance, has generally an inferior resistance to acids, about the same resistance to salts and a little better resistance to alkalies.

Both alloys are available in a wide range of Aloyco valve designs. They're cast by induction melting at Aloyco foundries and machined in Aloyco plants. New bulletin #9, couponed below, provides complete information. Write today to ALLOY STEEL PRODUCTS CO., INC., Linden, N. J.

5.7

Alloy Steel Products Company, Inc.
1303 West Elizabeth Avenue
Linden, New Jersey

Gentlemen:

Please send me a free copy of your Bulletin No. 9 on Monel and Nickel valves.

Name_____

Firm_____

Address_____

City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

year. Ultimate capacity for storing natural gas underground has increased about 2.4 times since 1950 when the capacity totaled 774 billion cubic feet.

At the end of the 1954 year, there were 6,395 wells operating in 172 pools in 17 states. A year earlier, there were 5,789 wells active in 167 pools in those states. At the end of the 1954 period, 12 new underground-storage pools were under construction. When completed, these pools will add another 180.4 billion feet to U. S. underground-storage capacity.

Socony Grants License To Produce Thiophene

Socony Mobil Oil Company has entered a licensing agreement with Sharples Chemicals, Inc., granting Sharples rights to manufacture thiophene under Socony Mobil patents.

Sharples, a subsidiary of Pennsylvania Salt Manufacturing Company, expects to go into full commercial production by midsummer. Thiophene will be produced at a new Houston plant operated by Index Chemicals Company, a subsidiary acquired earlier this year by Penn-Salt.

United Carbon to Buy Baytown Rubber Plant

United Carbon Company has signed a contract with the Rubber Producing Facilities Disposal Commission to buy the syathetic-rubber plant at Baytown, Texas. The price of the plant, if the sale is approved in Congress, will be $7,153,000.

The commission, when it sold 24 of the government's 27 synthetic-rubber plants earlier this year, rejected the only bid for the Baytown plant. General Tire & Rubber Company, which had been operating the plant, offered to pay $2,486,448.

United Carbon was one of nine companies which bid for the plant after it was offered for sale a second time. Two bidders, Goodyear Synthetic Rubber Company, which bought the copolymer plant at Houston (See **Who's Building**) and Thiokol Chemical Corporation, subsequently withdrew their offers.

Among the unsuccessful bidders were General Tire, which made another offer, and Baytown Rubber & Chemical Company, which was organized by employes of the plant and townspeople to submit a bid. Other companies bidding for the plant were American Resinous Chemicals Corporation, Food Machinery & Chemical Corporation, Edwin W. Pauley and Minnesota Mining & Manufacturing Company.

"Alamask"

offers a complete and diversified line of reodorants for petroleum and allied products

No longer need the products of the petroleum industry inflict upon their users the obnoxious odors resulting from the mercaptans and sulfides in their processing.

Years of development work and product-testing have culminated in a complete line of Alamask® reodorants that can successfully mask the objectionable odors of many petroleum products. Check this table to see which Alamask reodorants will solve your malodor problems:

"ALAMASK"	GASOLINE FRACTIONS	ASPHALTIC COMPOUNDS	KEROSENE BLENDS	COAL SPRAY OILS	SPACE HEATERS	CUTTING OILS	CLUTCH OILS	DIESEL FUELS	JET FUELS	MINERAL SPIRITS	WAXES	NAPHTHA	BURNER OILS
AAM								X					
AO						X	X						
AR		X								X			
BGM		X											
BN						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.10	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

Rhodia's chemists and engineers, experienced in odor abatement and waste disposal, will provide technical assistance to you in your efforts to correct malodors.

For complete information on these new, highly-effective reodorants, write today to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 230 Park Avenue, New York 17, N. Y.

Rhodia INC.

In Canada: Naugatuck Chemical Division, Dominion Rubber Co., Ltd.
Montreal Toronto Winnipeg

CHEMICALS WANTED

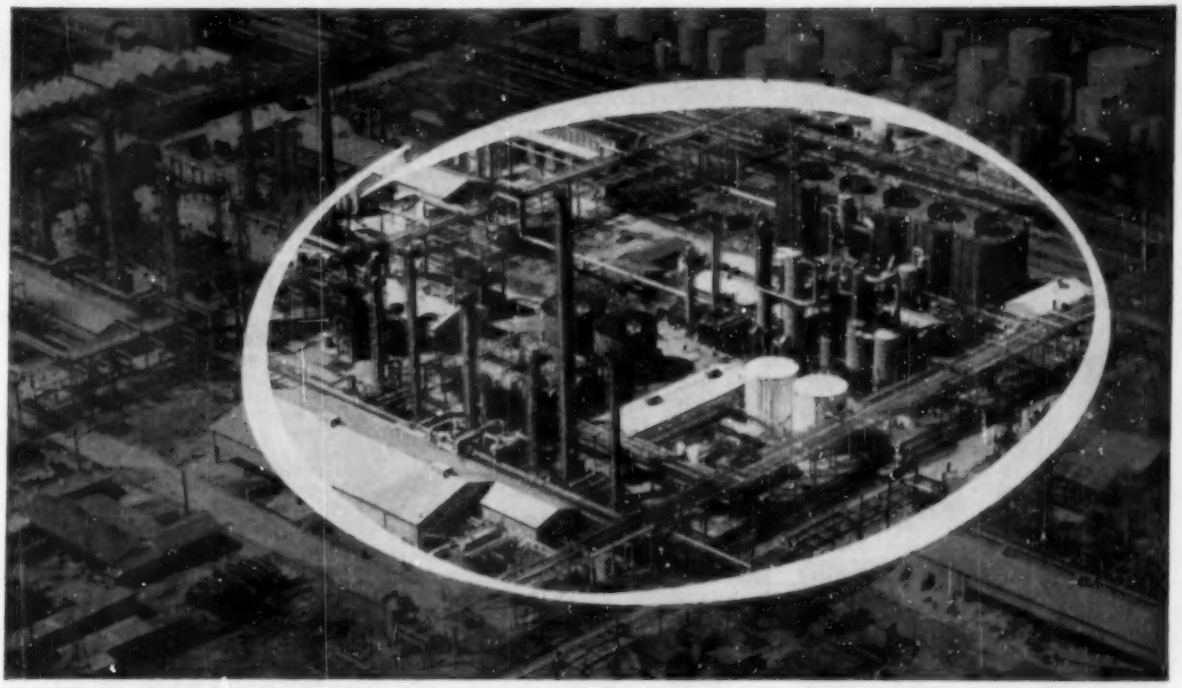
The National Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

2-Chloro-3-nitroaniline
2,3,5-Tribromoaniline
2,3,6-Tribromoaniline
2-Bromo-3-nitroaniline
2,3-Dibromoaniline
2,5-Dibromoaniline
2-Benzoyl-1,3-diphenyl-1,3-propanedione
1-Bromo-1-chloroethane
1,6-Heptadiene
Tetrahydro-2-methyl-6-(3-pyridyl)-2H-1,2-oxazine
3,5-Dinitrophenylisocyanate
4-Biphenyl isocyanate
1-Naphthylisothiocyanate
2,4,6-Trimethyl phenol (Mesitol)
1,2-Diaminocyclohexane
Chloroiodomethane
Bromoiodomethane
Phenanthro (1,10,9,8,fghij) perylene (meso-Naphthodianthrene)
4-Hydroxy-3-methyl-2-butanone
para-Hydroxyphenylacetaldehyde

Bureau of Mines Seeks To Continue Shale Work

Union Oil Company of California has taken another look at its plans to open a shale-oil plant, and now is seeking an agreement under which shale would be obtained from the Bureau of Mines' plant at Rifle, Colo. Meanwhile, the bureau is convinced it should go ahead with operation of the government retort at Rifle, despite an earlier decision to abandon the project.

Bureau officials want to continue their experiments because they do not believe



In this circle purity is an absolute must

...so is Nickel— and here's why

You are looking at a section of Shell Chemical Corporation's Deer Park, Texas, plant.

There, Shell synthesizes glycerine from propylene, with allyl chloride as an intermediate. There, too, the glycerine is evaporated, purified of salt, steam-stripped, distilled and stored.

All this means corrosion and purity problems. Chlorine and propylene are reacted at a temperature which greatly accelerates corrosive attack . . . salt is present in the crude product . . . and there are strict limits on the heavy metals content of glycerine.

Yet Shell successfully combats corrosion to turn out a colorless, odorless product that assays better than 99% glycerol and meets all the usual specification requirements.

How does Shell do it?

With Inconel; in mixing jets for reacting propylene and chlorine at about 950°F. Inconel combines resistance to both heat and corrosion.

With Nickel-Clad Steel; in evaporators, distillation columns, storage tanks . . . wherever glycerine is concentrated. Nickel-Clad Steel combines the protection of Nickel with the economy of steel.

With Monel; in continuous centrifugal filter equipment used to remove sodium chloride by-product. Monel gives high corrosion-resistance and high strength in a single metal.

With pure Nickel; in bubble caps and trays; reboiler and condenser tubes, pumps, and piping. Nickel keeps metal pick-up at a minimum in hard-to-maintain areas.

The correct application of Nickel and Nickel alloys in the production or handling of glycerine can do much to lower costs and improve the quality of the product. Inco's Corrosion Engineering Section will be glad to work with you in solving specific problems connected with purity or corrosion in your own plant. Just write:

THE INTERNATIONAL NICKEL CO., INC.
67 Wall Street **New York 5, N. Y.**

Inco Nickel Alloys

Monel® • "R"® Monel • "K"® Monel • "KR"® Monel
"S"® Monel • Inconel® • Inconel "X"®
Inconel "W"® • Incoloy® • Nimonic® Alloys
Nickel • Low Carbon Nickel • Duranickel®

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

they have solved the problems involved in mining shale. In testimony before the Senate Appropriations Committee, Roscoe A. Catell, the bureau's petroleum chief, said that production of oil from shale is very near a competitive level with petroleum, but described the main problem to be overcome as finding a safe, economical mining method.

Recalling Union Oil's plans to go into an experimental shale-oil program of its own, Catell told the committee that the company sought to buy government shale after the recent cave-in at Rifle showed mining methods there were not safe. (The company's plans call for a $5-million construction project at Rifle, including a retort designed for a daily capacity of 1000 tons.)

The Hoover Commission has recommended that oil-shale works be continued by the government "only until cost data under its methods are fully available." In its report on business enterprise in government, the commission declared that the present costs of getting products from shale oil "can not compete with the prices of petroleum products."

Refinery Cuts Runs

Ben Franklin Refining Company reduced crude runs at its Ardmore, Okla., refinery approximately 25 percent during May. The cutback was made to allow for inspection, repairs and installation of new equipment.

U. S. Refining Equals Half of World's Total

Capacity of British Commonwealth oil refineries at the end of 1954 totaled 77 million tons, an increase of 12 million tons over the previous year. According to a report of the Petroleum Information Bureau, the United Kingdom and Canada, each with more than 29 million tons, were the most important countries capacity-wise in the Commonwealth.

The information bureau put world capacity at 820 million tons at the end of the year, with the U. S. accounting for more than 50 percent. Outside the U. S., Western Europe was the leading area, with a 100-million-ton capacity, including British output. Other European refiners included France, with a 27-million-ton capacity; Italy, producing 21.5 million, and West Germany, producer of 11 million tons.

Brazil Invites Investors

Growing opportunities for U. S. companies to participate in Brazil's oil industry were stressed recently by Helio Beltrao, managing director of Petrobras, a new corporation created to supervise Brazilian oil operations.

Beltrao, in New York for a brief visit, pointed out that three new refineries have started operations in Brazil, with a total capacity of 80,000 barrels a day. By the end of the year, Brazil will be refining 110,000 barrels, or about 80 percent of its total consumption.

Sunray Mid-Continent One of Industries Largest

The oil industry's largest merger since 1932 has been approved by the stockholders of Sunray Oil Corporation and Mid-Continent Petroleum Corporation. The new company, to be known as Sunray Mid-Continent Oil Company, lists assets exceeding $486 million, ranking the merger second only to the Socony-Vacuum merger in 1932.

The new company, vaulted into the top 15 in the U. S., will operate a wholly-owned subsidiary, D-X Sunray Oil Company, to handle refinery, pipeline and marketing facilities. D-X Sunray, in turn, takes over a subsidiary for pipeline, Mid-Continent Pipe Line Company.

Chosen as chairman of the board was C. H. Wright, former Sunray chairman. Mid-Continent's president, R. W. McDowell, moves over as vice chairman. Sunray's president, W. C. Whaley, will hold the same position with the new company.

The merger has been described as the perfect solution for both companies. Sunray had production in excess of its refining capacity, while Mid-Continent's refining and marketing facilities exceeded its production. The combined refining capacity hits 100,000 barrels a day.

The new company also has a coking capacity of 18,000 barrels. Sunray held controlling interest in Ucan Products Company, which operates an 11,000-barrel-a-day coking plant adjacent to the Sunray refinery at Duncan, Okla. When the merger was completed Mid-Continent had work underway on construction of a 7000-barrel-a-day coker at its West Tulsa refinery. The unit, expected to cost $2.5 million, will reduce fuel oil output at the refinery to zero.

New Opportunities Seen For Synthetic Rubber

Chemical and allied-product industries are expected to spend about $11.1 billion this year for new plant and equipment. Department of Commerce has estimated that this expenditure will amount to $1894 per production worker, as compared to $813 for all manufacturing industries combined.

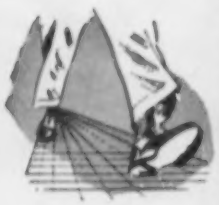
Citing the opportunity for increased output of synthetic rubber, a report by the department's Business & Defense Services Administration said that world requirements are rising at a rate of at least 4 percent a year, while the increase in natural-rubber production is about 1 percent a year.

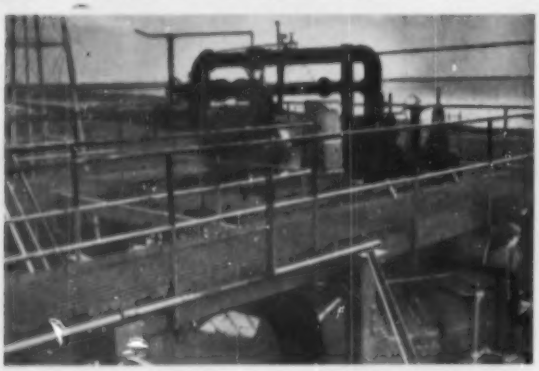
The agency, in its monthly Chemical & Rubber Industry Report, said that companies which recently purchased government synthetic-rubber facilities are challenged to increase production of synthetic rubber to meet expanding demands and to promote more intensive research in the use of synthetics as replacements for natural rubber.

Petroleum Council Plans New Manpower Study

National Petroleum Council will make a new study of U. S. peace-time requirements for manpower in the petroleum and natural-gas industries. The survey, to be

WHERE **SURE FOOTEDNESS** COUNTS





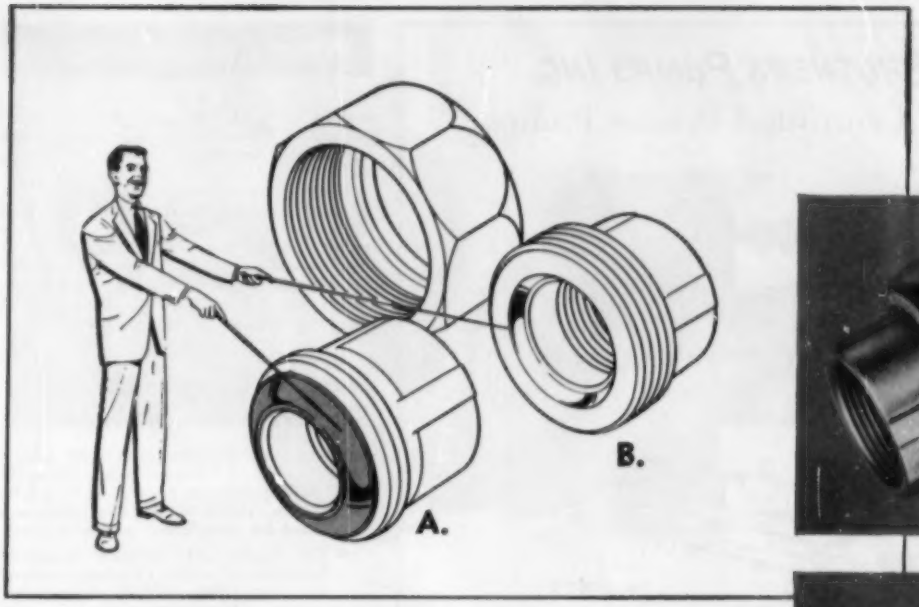
Gary

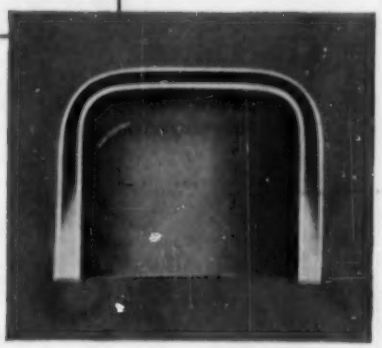
STEEL GRATING MAKES WALKS SAFER

Sturdy, one-piece construction with tops of all bars flush provides open steel flooring and stairs for safe, easier walking. Gary Grating is furnished in a wide variety of neat appearing designs and sizes—and is tailor-made to fit your needs. For complete description and installation pictures on Gary Welded Grating, Stair Treads and Gary-Irving Decking, ask for Catalog PR-65.

FREE SAMPLE
We'll send this handy paper weight if you request it on your company stationery.

Standard Steel Spring Division
ROCKWELL SPRING AND AXLE CO.
4011 East Seventh Avenue • Gary, Indiana





Because the male seat ("A" above) is 150 Brinnell harder than the female seat ("B")---

Rockwood unions will not gall in "making up"

Special engineering design and processing creates this hardness differential and the toughness you've been needing in replacement and new work. AISI Molychrome steel and *special* heat treating give the male seat its greater degree of hardness . . . preventing galling in "making up."

Exclusive Rockwood cold working process results in maximum resistance to expansion, shock, jar and vibration, thus insuring maximum long-life strength. Balanced design distributes this strength uniformly throughout.

You also get . . .

★ Seats double-locked under pressures of 100,000 and 400,000 lb.

★ Absolutely interchangeable parts for speedy replacements.

★ Plug type ball-to-cone design — no sharp corners — (eliminates scratching and damaging when making up in tight places).

★ "Rockwoodizing" protection of entire Union against corrosion.

Rockwood Unions are tested and listed by Underwriters' Laboratories, Inc. for use with flammable liquids and gases. Rockwood Steel Union #603 is the first to give such safety under pressure — and at great economy.

If you are not already using this new union, mail coupon today for full information.

In Processing Rockwood Cold Forged Steel Unions, cold working makes core fibers follow the shape of the union for best under-pressure performance. Creates a hard, high tensil, outer skin that will stand more abuse and has greater strength than any other union on the market.

ROCKWOOD SPRINKLER COMPANY

Worcester 5, Mass.

SEND FOR THIS INFORMATIVE BOOKLET

ROCKWOOD SPRINKLER COMPANY
646 Harlow Street
Worcester 5, Mass.

Please send me prices and further data on the new Rockwood Union #603. I would like the name of the nearest Rockwood distributor.

Name.....

Title.....

Company.....

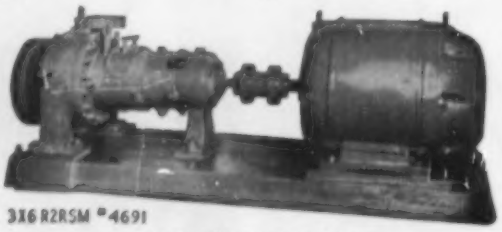
Street.....City.....

Zone..... State.....

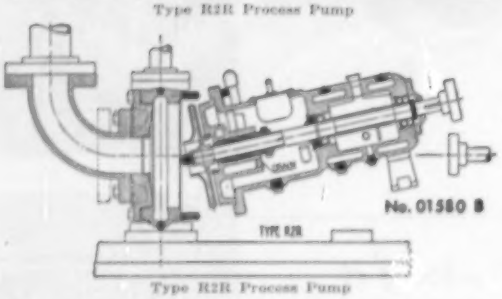
For more data on advertised products, use Readers' Service Cards, last page.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

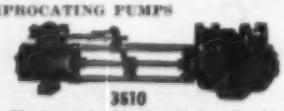
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

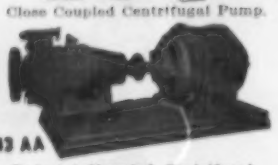
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

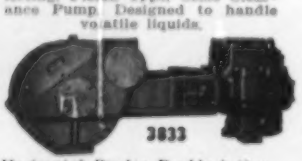
4044M
Close Coupled Centrifugal Pump.



3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids.



4043 AA
Pedestal Mounted Centrifugal Pump.



3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump.

4728
Double Pedestal Bearing Centrifugal Pump.

3554
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type.

ESTABLISHED 1869
DEAN BROTHERS PUMPS INC.
INDIANAPOLIS IND.
323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

What's Happening. . .

broken down by functional division, occupational skills and geographic areas, would update the last study, completed in May, 1951.

Plans for conducting another study of oil and gas requirements were approved after Carrol D. Fentress, acting director of the Interior Department's Office of Oil & Gas, noted that new information would be valuable to the Military Petroleum Advisory Board. The board is concerned with war-time manpower requirements.

Five Oil Companies Receive Safety Awards

Five petroleum companies were among the recipients of National Safety Council's 1954 Public Interest Awards. The advertising campaigns of the five companies were cited for exceptional service to safety.

- The Carter Oil Company sponsored hundreds of radio announcements featuring safety; placed accident-prevention advertisements in 150 newspapers, and devoted its entire 212 outdoor-poster schedule for July to a campaign against high speeds.
- Crown Central Petroleum Company sponsored 662 outdoor-safety posters; distributed 15,000 small posters to offices and shops, and handed out 200,000 "Drive Safely" plates for automobiles.
- Esso Standard Oil Company reactivated its Esso Safety Foundation, which gives grants to universities and others for advancing highway safety; sponsored safety messages on 250 billboards a month, and devoted announcement time to accident prevention on its weekly radio and TV programs.
- The Jenney Manufacturing Company provided free reflectorized tape for children who brought their bikes to company gas stations.
- Standard Oil Company (Indiana) promoted safety in its newscasts over 30 radio stations, with full-length safety messages scheduled on all stations during the high-accident months.

Magnolia Employes Move To New Jobs in Beaumont

Some 105 Magnolia Petroleum Company employes are moving from Fort Worth to Beaumont, Texas, in what is believed to be the largest shift of employes and their families ever made in the Southwest. The move involves employes who accepted jobs at Magnolia's refinery in Beaumont after its Fort Worth refinery was shut down.

All except 21 newer employes of the total 200 at the Fort Worth plant either were offered new jobs in Beaumont or were given accelerated retirement. The employes terminated received an allowance based on their service with the company.

The Fort Worth plant began shut-down procedures May 1. It had a daily crude capacity of 8500 barrels, as compared to the company's Beaumont refinery which has approximately 180,000-barrels-a-day capacity. The plant in Fort Worth had been operated as part of Magnolia's refining system since Christmas Day, 1914.

It's in the Bag!

Fresh, Clean Ink for a Year of Trouble-free Recording

★ You won't have any messy, time-consuming re-inking of pens on the new Bailey Recorders. The entire system is white-glove clean—hermetically sealed, non-evaporating, non-corrosive. Gone is any chance of sludge or oxide formation. Gone are clogged pens, interrupted records, unsightly splashes.

The transparent plastic ink sacs are changed once a year—that's all. Capillary tubing carries fresh, clean ink to the pens continuously without any day-to-day attention.

This exclusive new inking system* is only one of the many time-saving, money-saving distinctive features of the new Bailey Recorder.

Ask for Product Specification E12-5. P34-1

*Now available for the New Bailey Recorder only.

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY
METER COMPANY
1043 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

For more data on advertised products, use Readers' Service Cards, last page.

For reforming natural gas **Stainless Steel**

If you could peek inside equipment used for production of synthetic gas and hydrogen, you would see a veritable showplace for Stainless Steel.

Without Stainless Steel tubing and devices, maintenance costs would go through the roof. With Stainless Steel, the greatest freedom from severe petrochemical service is the usual result.

Of course, there is the job of selecting just the right Stainless Steel composition . . . the composition with the best performance cost ratio. This problem is discussed in our booklet, "Performance of Stainless Steel in Petroleum Refinery Service."

Your copy is waiting. Just write to United States Steel, Room 4734, 525 William Penn Place, Pittsburgh 30, Pa., and we shall be glad to send you a copy.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

See "THE UNITED STATES STEEL HOUR"—Televised alternate weeks—Consult your newspaper for time and station.

USS STAINLESS STEEL

SHEETS · STRIP · PLATES
BARS · BILLETS

USS

PIPE · TUBES · WIRE
SPECIAL SECTIONS

UNITED STATES STEEL

What's Happening . . .

. . . *Among Men* in the Industry

Gardiner Symonds, president of Tennessee Gas Transmission Company, has been elected chairman of the newly-organized Petro Tex Chemical Corporation. President and chief executive officer of the new convern will be Paul L. Davies, who also is president of Food Machinery & Chemical Corporation.

The company, owned jointly by FMC and TGT, will operate the 90,000-ton-a-year butadiene plant recently purchased in Houston. (See **Who's Building.**)

Joseph R. Mares, formerly vice president of Monsanto Chemical Company and more recently a chemical consultant, was selected as managing director of the new company. Two vice presidents will be Gordon A. Cain, who was assistant to the manager of FMC's Westvaco Mineral Products division, and R. V. Mertz, formerly superintendent of TGT's compressor stations.

Cain, who also was named as treasurer, will be assisted in that position by J. P. Lockwood, formerly with TGT's treasurer. With his duties as assistant treasurer, Lockwood also will serve as secretary of the new company.

In addition to Symond, Davies and Mares, the Petro-Tex board will include Ernest Hart and Dr. Carl F. Prutton, both vice presidents and directors of FMC, and R. R. Dean and J. J. King, both TGT vice presidents.

Marion W. Boyer, executive vice president of Esso Standard Oil Company, has been named as a director of the parent company, Standard Oil Company (New Jersey).

J. E. Vaeth, executive vice president of Southern Production Company, Inc., has been honored for 35 years' service with the company. Vaeth, whose service includes 30 years with Danciger Oil & Refining Company before its merger with Southern Production in 1950, received a silver tea service in ceremonies at the company's Fort Worth offices.

W. C. Lowrey heads a list of five district managers receiving new assignments in Shell Chemical Corporation's Marketing division. Formerly in charge of the company's district office in St. Louis, Mo., Lowrey was named to manage the Newark, N. J., district.

W. A. McCormick, formerly a member of the general sales manager's staff, was named to replace Lowrey as manager at St. Louis. R. W. Campbell, who was senior technical salesman for the Los Angeles district, was promoted to district manager there.

Formerly district manager at New York, G. E. Garland, was appointed to the general manager's staff. Changing places with him is D. P. Jones, member of the sales manager's staff assigned to the New York district as its manager.

Miller

Baldeschwieler

E.L. Baldeschwieler and **A.E. Miller,** two petroleum chemists whose combined service to the oil industry totals 75 years, have been recognized for their work with API "Certificates of Appreciation." The awards were made at the refiners' annual dinner held during the Division of Refining's Midyear Meeting in St. Louis.

Baldeschwieler, a Swiss-born analytical chemist, recently retired as laboratory director for Esso Research & Engineering Company at Linden, N. J. Educated at the Ecole de Commerce in Switzerland and at Cooper Union in the U. S., he is author of a number of scientific articles, and has been granted several patents. Baldeschwieler's citation reads in part:

"A chemist in the purest sense, he believes that analytical chemistry should be applied more widely for the advancement of petroleum technology. He had led his profession toward a broader role in the operation of the petroleum industry. His keen perception, broad knowledge and thorough comprehension place him in the forefront of the Committee on Analytical Research. Under his leadership, the committee attained high status in the Division of Refining."

Miller began his service with the oil industry in 1912, after graduation from Pennsylvania State College. He joined Sinclair Refining Company in 1918 as a process chemist, and in 1948, was named to his present position as assistant to the vice president in charge of research and development.

During World War II, he was secretary of the Technical Advisory committee of the Petroleum War Council and secretary of the Lubricating Oil Advisory Committee of the Petroleum Administration for War. Besides the Division of Refining, Miller also has served the API Divisions of Production and Marketing and the Advisory Committee on Fundamental Research. His citation read in part:

"A convivial companion, tireless worker and eager participant, he has given unstintingly of his time to the projects of the Committee on Petroleum Products for many years. With dogged devotion and stubborn persistence, he brought many projects to fruition when others had given up in dismay."

Carl A. Lemon, formerly assistant sales manager for Sunray Oil Corporation, will be manager of absorption plant product sales for the merged Sunray Mid-Continent Oil Company.

Lemon's department will handle sales from 26 field units which Sunray Mid-Continent either owns, operates or in which it has partial ownership. These plants include 16 units in which Sunray had an interest prior to the May 16 merger, the four plants formerly owned and operated by Mid-Continent Petroleum Corporation, and Mid-Continent's interest in six other installations.

Geor_ e V. Holton will retire as chairman of Socony Mobil Oil Company, Inc., (formerly Socony-Vacuum Oil Company), after 26 years as director of the company and one of its antecedents, Vacuum Oil Company. Prior to becoming chairman in 1948, he was vice president and general counsel as well as director.

W. G. Moore, a veteran of more than 20 years with Gulf Oil Corporation, has retired as assistant to the president. During his service with Gulf, Moore had been

What's Happening. . .

concerned largely with economics and coordination of the company's major operations. More recently, he had been engaged in developing the company's petrochemical interests.

Lewis W. Douglas, former U. S. ambassador to Great Britain, and P. Malozemoff, both of New York, have been elected to the board of Continental Oil Company.

F. C. Love has been selected as president of a new subsidiary being set up to handle refining, pipe lining and marketing operations for Kerr-McGee Oil Industries, Inc. In addition to Love, who will continue as general vice president of the parent company, five vice presidents were named for the new Deep Rock Oil Company.

They are John G. Campbell, formerly head of the Supplies & Economics division for Kerr-McGee's recently-acquired Deep Rock Oil Corporation; Robert M. Chesney, manager of the Deep Rock refinery at Cushing, Okla., since 1951; James J. Kelly, associated with Kerr-McGee since 1946; William M. Murray, a member of the Deep Rock organization for more than 25 years, and Jack W. Roach, who joined Kerr-McGee in 1952 as manager of operations for the Refining division.

Sterling P. Blumberg has been promoted to senior research chemical engineer in the Research & Development division at Humble Oil & Refining Company's Baytown, Texas, refinery. With Humble since 1943, Blumberg will follow plant operations in the production of gasolines, solvents and specialties, particularly in catalytic-polymerization operations.

Leesemann Kuehler Hall

C. J. G. Leesemann is one of three Humble Oil & Refining Company engineers receiving promotions in the Technical and Research divisions at the company's refinery in Baytown, Texas. Leesemann has been named as a new research associate in the Research & Development division.

Appointed as technical associates in the Technical Service division are P. N. Kuehler and I. D. Hall. Both now are serving in Humble's Executive Development Program as assistant division heads for Technical Service.

Leesemann, a chemical engineering graduate from Rice Institute, is chairman of the Refining Patent committee, handling technical aspects of patent and legal matters. He also is responsible for the application of new mathematical techniques and machine computations to research problems.

Holder of a M.S. degree in chemical engineering from the University of Tennessee, Kuehler, who has a wide experience in many phases of refining technology, has filled various supervisory positions in the company's Technical and Research divisions. Hall, who received his chemical engineering degree from the University of Texas, was selected in 1944 to head the technical staff at the government-owned butadiene plant at the refinery, and for eight years was head of various sections in the Technical Service.

Jesse M. Carr, Jr., has joined Esso Standard Oil Company at its laboratories in Baton Rouge, La. Carr received his B.S. and M.S. degrees in chemical engineering from Virginia Polytechnic Institute.

John M. Sprague has been elected vice president of The Carter Oil Company. Manager of the company's Eastern division operations in Illinois, Indiana, Michigan and Kentucky for the past 18 months, he will be succeeded by R. C. Curtis, production superintendent for the division. Sprague will make his headquarters in Tulsa.

Forney Hutchinson, Jr., who was industrial relations manager for the former Sunray Oil Corporation, has been given charge of the new Sunray Mid-Continent Oil Company's Employe Relations department. The functions of the department generally will remain the same as they were before the recent merger with Mid-Continent Petroleum Corporation.

George Hinckley, with Utah Oil Refining Company in Salt Lake City, has been elected chairman of the Rocky Moun-

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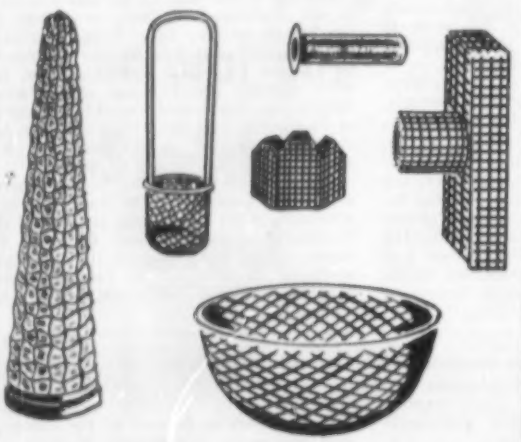

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What's Happening. . .

tain Oil & Gas Association's Refining division. He succeeds Harry A. Brown, vice president of Frontier Refining Company and superintendent of the company's refinery in Cheyenne, Wyo.

Elected as vice chairman of the refining group was J. A. Ramsey, with Continental Oil Company at Billings, Mont. Brown was elected to serve as the association's counselor.

Hartough

Cross

Howard D. Hartough is one of four receiving new assignments with Houdry Process Corporation. For the past year head of the company's Research section, Hartough was promoted to director of product sales and market development for the Chemical division.

Receiving an advancement with him in the Chemical division is Ray Cross, formerly manager of the Houdry catalyst-manufacturing plant at Paulsboro, N. J. He was appointed director of product manufacture.

Also promoted in the Houdry organization are two contributors to this month's Petroleum REFINER. They are Jack C. Dart and Dr. Alex G. Oblad, co-authors of the article appearing on page 153.

Dart, a newly-elected member of the board of directors, was appointed manager of the Chemical division, and Dr. Oblad was selected to succeed him as manager of Houdry's research and development laboratories at Linwood, Pa.

John H. Stotts has been appointed research chemist in Continental Oil Company's Development and Research department. He will make his headquarters in Ponca City, Okla.

Stotts, associated with Procter & Gamble Company in Cincinnati since 1948, is a graduate of the University of North Carolina. With Conoco, he will specialize in petrochemical research.

Duer Reeves, executive vice president of Esso Research & Engineering Company, has been elected president of the Industrial Research Institute. In assuming office at the institute's spring meeting, he predicted that expenditures for industrial research will more than double during the next ten years.

"Currently, about $3 billion is being spent in industrial laboratories by private companies and the U. S. government," he reported. "An additional $1 billion is being spent by the U. S. in government laboratories."

Reeves started his research career in 1930 when he joined the Standard Oil Company (New Jersey). He was closely associated with the development of fluid catalytic cracking. He has been executive vice president of the company since 1949.

Frank J. Smith, who was manager of The Atlantic Oil Company's Petrochemical division, now is vice president and general sales manager, a director and member of the executive committee of the newly-formed subsidiary, Pan American Chemical Corporation. The new company will market petrochemicals produced at the American company's plant in Texas City, Texas.

Smith

Smith, who will continue to headquarter in New York, joined the company as assistant director of research at Texas City in 1942. He was transferred to New York in 1947 as head of the Chemicals division.

J. H. Sembower, West Coast public relations manager for Shell Oil Company, has been transferred from San Francisco to Los Angeles in a series of moves establishing Los Angeles as headquarters for the company's Public Relations department on the West Coast.

Sembower

The moves call for P. W. Harvey, public relations representative in Los Angeles for the past year, to be sent to San Francisco. Replacing Harvey in Los Angeles is T. F. Scoggins, New Orleans representative for the past three years. And to be sent from San Francisco to a newly-created Northwest public-relations post in Seattle is W. L. Gordon.

Sembower, who joined Shell in 1938, has been head of the company's public-relations activities on the West Coast since 1949. Previously, he had been in charge of personnel and industrial-relations functions for the Southwest. He was one time manager of the Public Relations department in New York.

S. Price Gray, assistant secretary and assistant treasurer of Sunray Oil Corporation, has been named manager of the company's General Accounting department. He will headquarter in the general offices at Tulsa.

Raymond L. Cassell has been appointed divisional chief plant engineer for American Cyanamid Company's Organic Chemicals division. He will be responsible for administration of the Plant Engineering department at the company's Bound Brook, N. J., plant, and carry staff responsibility for plant engineering operations throughout the division.

Cassell joined Cyanamid in 1934 as chief draftsman at the Bound Brook plant; in 1944 was appointed assistant chief engineer, and in 1949 moved up to chief plant

SAFEST

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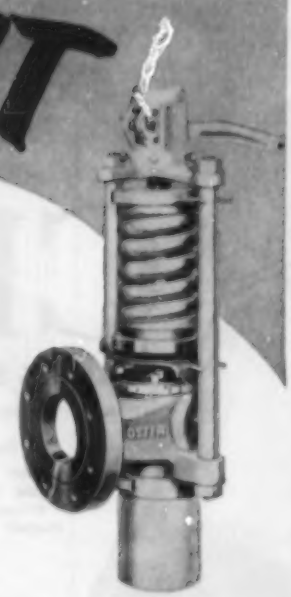
There are also many Super-Jets set to pop at pressures ranging down to as low as 8 psi in turbine relief service and reducing valve stations.

Regardless of operating pressures or temperatures the Foster 38-SV Super-Jet Safety Valve guarantees you a positive factor of safety in protection of life, limb and property from overpressure.



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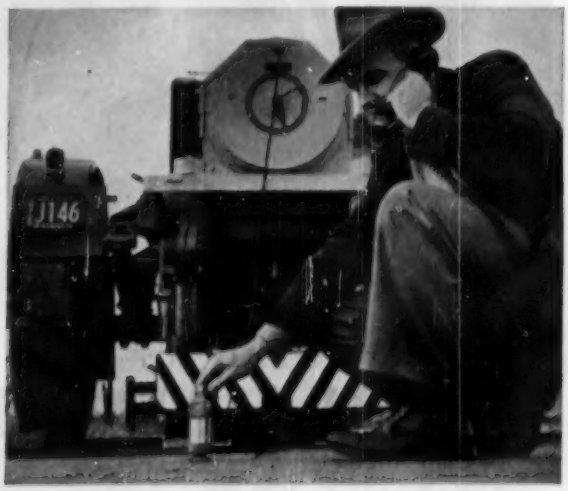
AUTOMATIC VALVES SAFETY VALVES FLOW TUBES

SHELL REPORTS

A PICTURE ROUNDUP OF SOME ACTIVITIES THAT MADE NEWS OUTSIDE THE PETROLEUM WORLD

A CAPITAL CONTRACT. To power its new turbo-prop Viscounts, Capital Airlines has selected Shell Oil Company as its supplier of fuel. Throughout flight history, as aeronautical engineers have built new engines and new planes, Shell research has developed the fuels to fly them. Shell Oil Company, leading supplier of aviation fuels to the United States commercial airlines, is helping turbo-prop travel become available for everybody.

ROCK AGER. What Mother Nature takes 10 million years to accomplish, Shell's atom smasher completes in one week. Behind thick walls, particles of rock are bombarded with radiation and thus aged by the first 2-million-volt Van De Graff accelerator in the petroleum industry. In this way, members of Shell's Exploration and Production Research Division are learning more about the age of rock and the origin of oil. Shell's advanced techniques in oil research are a strong investment in today to provide for tomorrow.



HITTING THE ROAD. It's the new method developed by Shell to measure the load-carrying capacity of asphalt. Electronic impulses simulate the jarring effects of traffic, and record the effects of continuous vehicular movement. Without damaging the highways, engineers get a long-range picture of how much a road can take. Shell's research is a step towards a better understanding of road requirements — and to more efficient, longer-lasting highways in the future.

SHELL

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What's Happening. . .

engineer. Prior to his association with Cyanamid, he was assistant to the president and chief engineer of Duke Power Company.

L. C. Kemp, Jr., has been appointed general manager of The Texas Company's newly-created Petrochemical department. Director of research for the company from 1941 to 1953, he will make his headquarters in New York.

Kemp

Kemp joined Texaco in 1929 as a research chemical engineer at the refinery in Port Arthur and later served in various managerial capacities in the research field. He is a chemical-engineering graduate from Rice Institute.

Charles V. Owen, formerly a graduate instructor in civil engineering at the University of Arkansas, has joined the field-engineering staff of The Asphalt Institute. Another addition to the institute's staff is John D. Coughlin, a former Navy photographer and Central Intelligence Agency film productor, now assigned to the information staff.

Since his graduation from Arkansas in 1952, Owen has been teaching asphalt construction and design at the university and working as research assistant in charge of the asphalt laboratory on a Joint Highway Research Project, sponsored by the Arkansas Highway Department.

Coughlin served three years as a Navy photographer in the submarine service with the Pacific forces; was advertising photographer with Ingersoll Rand Company, and was employed with the CIA.

Thomas F. McGarey, former Philadelphia regional manager for Cities Service Oil Company (Pennsylvania), has been elected vice president in charge of the company's Asphalt division.

Rudolph Groth-Marnat has been appointed manager of export sales for Brea Chemicals, Inc., a subsidiary of Union Oil Company of California. He formerly was Southern California manager of Grace & Company's Import-Export division.

Groth-Marnat

Groth-Marnat was born in Mexico City, studied languages and science in Germany and specialized in chemistry and physics in England. He entered the import-export and banking business in Germany; sold automotive equipment in Mexico, and later was purchasing agent for a Mexican firm before he came to the U. S.

Dice

Kirk

Marion E. Dice has been appointed assistant to the president of General Petroleum Corporation. Formerly manager of the company's Economics department, he will be succeeded by William F. Kirk, his assistant for the past six years.

Dice, who started with General Petroleum in 1923 as a draftsman, served a year as technical assistant to the president before he was given charge of the Economics department in 1944. Kirk has been with the company since 1929, except for the war years which he served in the Army and another period in which he served as assistant director of the Program division of the Petroleum Administration for Defense.

Marvin L. Gosney, executive vice president of Sinclair Oil Corporation since 1949, has been elevated to chairman. A former banker, Gosney joined the Sinclair organization in 1917 as treasurer of Sinclair Refining Company.

J. A. Neath has been elected chairman of the Humble Oil & Refining Company, succeeding L. T. Barrow, who plans to retire from the post he has held since 1948. Simultaneously, C. E. Reistle, Jr., was named vice president, replacing David Frame, who also is retiring.

Other changes in the Humble board include the election of three veteran employes as directors. They are Herman P. Pressler, Jr., associate general counsel; Ralph J. Schilthuis, superintendent of the Gas division, and Ray H. Horton, employe-relations manager.

Thomas A. McCoy has been appointed manager of Texas-U. S. Chemical Company. He will head operations at the company's recently-acquired synthetic-rubber facilities in Port Neches, Texas.

McCoy

The Texas Company and U. S. Rubber Company share interest in the Texas-U. S. Company, which recently purchased one of the government's copolymer plants at Port Neches and half interest in a butadiene plant there.

McCoy, who had been manager of one of the plants in Port Neches since it was activated in 1950, began his career in synthetic rubber in 1944 as a project engineer at the plant in Institute, W. Va., where he later became plant engineer. He later transferred to Borger, Texas, where he rose to factory manager.

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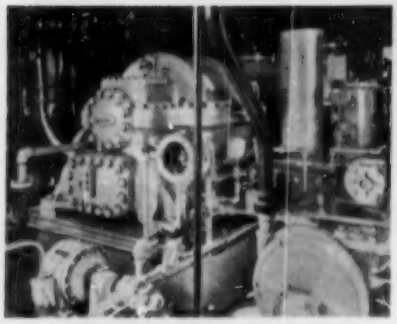

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Carrier makes a complete line of centrifugal and axial flow compressors for gas compression and refrigeration—up to 10,000 hp. in a single unit. There are hundreds of dependable, efficient Carrier machines on the job for dozens of refineries across the country—The Atlantic Refining Company, Cities Service Oil Company, Sinclair Oil Corporation, The Texas Company. May we assist you?

If you'd like a copy of our booklet **"Centrifugal Compressors for Industry"** please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

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Who's Meeting . . .

Plans Electrical Conference—

H. M. Stewart, with Humble Oil & Refining Company in Baytown, Texas, makes plans for the forthcoming Electrical Conference of the Petroleum Industry, to be held in Houston, September 12-14. Sponsored by the AIEE, this will be the second year for the meeting. Stewart is conference chairman.

Automation Is Here*

. . . **The key** to widespread use of automation is flexibility — permitting industry to switch quickly from one type of assembly to another. The small supplier is definitely in the picture but flexibility will be more important to him than to the "big fellows." In some instances the smaller manufacturer will be spared many of the headaches of automation since he will not have to tie up large amounts of capital in research and creative engineering, as will the big manufacturer.

Automation should be referred to in the present tense since it is here. The big problem for the engineer now is not the decision "can it be done?" but "when should it be done?" The engineer must also broaden his thinking so he may see automation as a whole and not as a mere machine. (W. R. G. Baker, General Electric Company, Schenectady, New York.)

. . . **A short supply** of highly trained men will present the most vexing problem as the America of the future relies more heavily upon automation in terms of uranium and the sun for sources of energy. It was predicted that the current shortage of engineers will continue into the future despite a growth of population. America will need highly trained men to carry out an expanding program of automation. The reason for the new interest in automation—it actually had a beginning in 1661 with the invention of an automatic loom—is that we have found a way of giving machines the power of decision. However, giant brains have a long way to go before they can replace even children much less engineers in the performance of their work. (E. A. Walker, Pennsylvania State University, State College, Pennsylvania.)

. . . **Automation** will make a big inroads into architecture. The number of parts in a building though prefabricated, has been steadily increas-

* Symposium on "Automation-Engineering for Tomorrow," Michigan State College, East Lansing, Mich., May 13, 1955.

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Precision assembly in the shop prior to shipment expedites construction in the field. Cranes and other facilities are available at Newport News for complete assembly of weldments of almost any size to meet the customer's requirements.

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It's a pressure vessel in an overseas petroleum refinery. And it caps *sixty-seven* years' experience by the Newport News Shipbuilding and Dry Dock Company. Sixty-seven years, building just about any kind of vessel you could name. And at a price.

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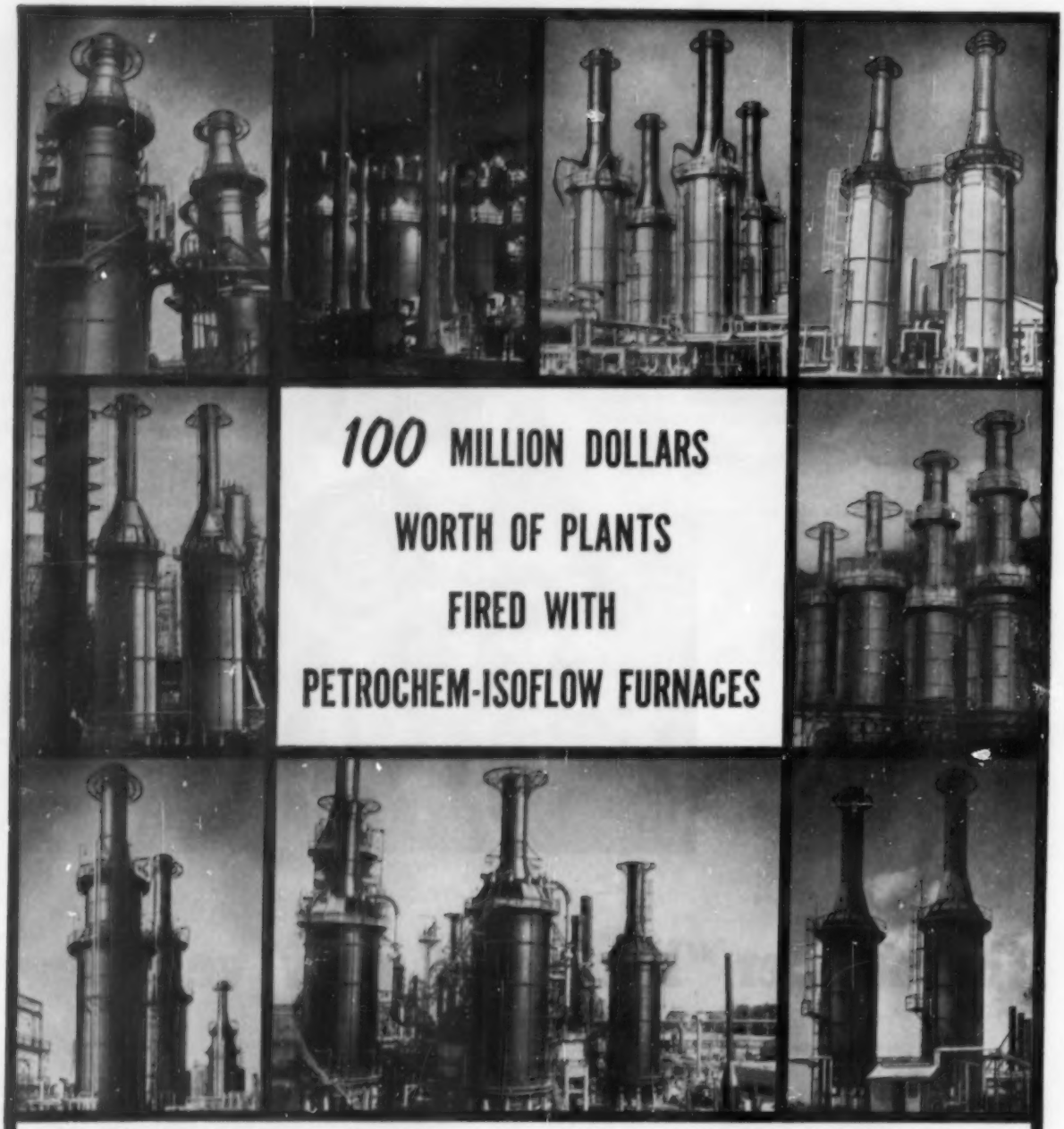

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Who's Meeting . . .

ing for generations. The next step is the development of cheaper and better buildings by a reduction in the number of different prefabricated units required to construct it. (E. X. Tuttle, Giffels and Vallet, Inc., Detroit, Michigan.)

New Engine Classification?*

A revision in the American Petroleum Institute Classification system for internal combustion engine service was recommended to the API's Lubrication Committee by a subcommittee appointed to review the system which has been in use since 1952, as a guide in the choice of crankcase oil.

The most important changes recommended are as follows: First, a new title which emphasizes that the API System is one of engine service classifications, not oil classification. Second, emphasis that Service MS represents the most severe for gasoline engines. Third, the inclusion of a third service classification for diesel engines, recognizing both the technical need and current commercial practice. Fourth, the addition of remarks concerning the use of multiple service designations for oils used in diesel engines. Other changes include consistent use of the term "crankcase oil" and introductory comments regarding gasoline engine service to make this section consistent with the diesel section. The suggested revision will be submitted to all committee members for approval by letter ballot.

In the Future . . .

. . . **ASME** will have a technical paper on the process design of tubular heaters (Boston, Mass., June 19-24) . . . Also will sponsor a conference on combustion with The Institution of Mechanical Engineers, (Cambridge, Massachusetts, June 15-17) . . . **NACE** Permian Basin Section plans its annual corrosion tour, one of the stops being Cosden's Big Spring, Texas, refinery (Odessa, Texas, October 12-14) . . . Niagara Frontier Section of **NACE** will sponsor a panel on underground structure corrosion (Niagara Falls, November 1-3) . . . **AIChE** plans a symposium on the growth of the oil and chemical industry by integration (Lake Placid, New York, September 26-28) . . . Philadelphia **ISA** chapter will have "Automatic Control Loops—Electronic or Pneumatic?" as its theme (Philadelphia, October 28-29) . . . Atmospheric corrosion of non-ferrous metals will be one of the symposia at the annual **ASTM** meeting (Atlantic City, June 27-July 1).

* American Petroleum Institute Lubrication Committee, White Sulphur Springs, Va., May 16-18, 1955.

MEETINGS CALENDAR

JUNE	
9–10	Natural Gas & Petroleum Association of Canada, Royal Connaught, Hamilton, Ont., Canada.
12–17	Society of Automotive Engineers Golden Anniversary Summer Meeting, Chalfonte Haddon Hall, Atlantic City, N.J.
20–23	American Society of Mechanical Engineers (Semi-Annual Meeting), Statler Hotel, Boston, Mass.
23–24	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Broadview Hotel, Wichita, Kansas.
26–July 1	American Society for Testing Materials Committee D-2, Petroleum Products and Lubricants, Chalfonte Haddon Hall, Atlantic City, N.J.
SEPT.	
12–14	American Institute of Electrical Engineers (Electrical Conference of the Petroleum Industry), Shamrock Hotel, Houston.
14–16	National Petroleum Association (Annual Meeting), Traymore Hotel, Atlantic City, N.J.
22–23	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Hotel Henning, Casper, Wyo.
22–23	Mid-Continental Oil & Gas Association, Louisiana-Arkansas Division (Annual Meeting), Roosevelt Hotel, New Orleans.
25–28	American Institute of Chemical Engineers, Lake Placid Club, Lake Placid, N.Y.
25–28	American Society of Mechanical Engineers (1955 Petroleum Mechanical Engineering Conference), Roosevelt Hotel, New Orleans.
25–28	American Institute of Chemical Engineers, Lake Placid Club, Lake Placid, N.Y.
OCT.	
2– 6	American Society for Testing Materials Committee D-2, Petroleum Products and Lubricants, Statler Hotel, Washington, D.C.
3– 7	American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago.
12–14	National Association of Corrosion Engineers, Permian Basin Section, (Biennial Permian Basin Corrosion Tour), Headquarters at Lincoln Hotel, Odessa, Texas.
13–14	California Natural Gasoline Association (Annual Fall Meeting), Ambassador Hotel, Los Angeles.
17–19	American Gas Association (Annual Convention), Los Angeles.
18–22	National Safety Congress & Exposition, Sponsored by National Safety Council, Chicago.
20–21	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting, Garrett Hotel, El Dorado, Ark.
24–26	American Standards Association (Annual Meeting), Sheraton Park Hotel, Washington, D.C.
27–29	Rocky Mountain Oil & Gas Association (Annual Convention), Cosmopolitan Hotel, Denver, Colo.
31–Nov. 2	Society of Automotive Engineers (Transportation Meeting), Chase Hotel, St. Louis, Mo.
31–Nov. 2	National Lubricating Grease Institute (Annual Meeting), Edgewater Beach Hotel, Chicago.

REVOLUTIONARY ORIFICE PLATES By MAC-IRON

PAT. PEND. (Exclusive MAC-IRON process)

ANOTHER SMASH HIT!

- Standard ring gasket—one piece, simple construction, **all plates precision ground**—minimum turbulence.
- Time saving, inexpensive—all measurements established, nothing special, instantly available—pipe fabricating delays eliminated.
- Equipment damage impossible—no bolts to loosen.

You'll want complete information. Write direct today.

The Mack Iron Works Company
Warren and Water Sts. Sandusky, O.

FOR REPLACEMENTS ORDER HIGH PRESSURE
GAGE GLASSES
MAGNIFYING RED LINE

MASTER STANDARD RED LINE & CLEAR *Up to 500 lbs.*

MASTER CLEAR & RED LINE EXTRA STRONG *Up to 600 lbs.*

Made in Lengths up to 144" Long
And Outside Diameters ⅝", ½", ⅝", ¾", ⅞", 1", 1¼", 1½".

High Pressure Composition
ERNST RUBBER GASKETS
All sizes to fit your gages and valves

FIG. 21—Lip Mold FIG. 22—Standard

ERNST WATER COLUMN & GAGE CO.
Send for Catalog LIVINGSTON, N. J.

For more data on advertised products, use Readers' Service Cards, last page.

Our Construction Forces erecting a 135-foot [illegible] vessel which forms a part of a new large petro-chemical plant designed by our engineering staff.

Engineering and Construction

BADGER MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASS. 60 EAST 42nd STREET, NEW YORK 17, N.Y.

What Suppliers Are Doing . . .

Yates | Coombe | Breckenridge | Norton | Plomp | Wallis | Rove | Fuller | Harcus

D. J. Yates, who for the past ten years has represented **The Bristol Company** in its Pittsburgh territory, now is in Los Angeles. He was transferred to the West Coast as socket-screw field representative.

H. James Coombe, president of **The William Powell Company** since 1941, has been made chairman of the board. He will continue as the company's chief executive officer. Moved up to take the president's place is David M. Forker, who had been executive vice president for the past two years.

Robert B. Breckenridge, until recently with the U. S. Bureau of Standards and the Office of Naval Research, has joined **Union Carbide & Carbon Corporation** as head of the research laboratories it is building at Parma, Ohio. Much of the work at the laboratories will be devoted to solid state physics. Much of Dr. Breckenridge's work for the government was in this field.

Phil Norton, vice president in charge of sales for **Wisconsin Motor Corporation** since 1930, has been elevated to executive vice president. Norton has been with the company since 1924.

Albert E. Plomp has joined **Chiksan of Canada, Ltd.,** as a senior salesman. Formerly associated with Lion Oil Company and Kellogg Company of Canada, he will headquarter in Calgary.

Buel M. Wallis is the new general sales manager for **Schield Bantam Company.** Formerly in charge of sales for the Adams Division, LeTourneau-Westinghouse Company, he had served J. D. Adams Company for 25 years as manager of the Washington, D. C., office, export manager, manager of government sales and finally as general sales manager.

Louis C. Rove, who has been special representative for **Nordberg Manufacturing Company** since World War II, is now district manager for the company's Great Lakes territory, including Michigan, Indiana, Ohio, western Pennsylvania and eastern Kentucky. He succeeds William C. Young, who has been assigned to the Industrial & Petroleum Sales staff.

C. C. Fuller, assistant general sales manager of **The Foxboro Company** since 1941, has been made vice president, augmenting the sales staff. He succeeds C. E. Sullivan, who has retired from active sales direction but continues with the company as a consultant. H. O. Ehrisman, another assistant general sales manager, was appointed general sales manager.

Robert Harcus, executive vice president of **Byron Jackson Company,** has been named to the Membership Advisory Council of the Atomic Industrial Forum. The group was formed to study technical, legal and managerial problems relating to the development of atomic power for industrial purposes.

Bonnette | Clark | Burrows | Strickland | Van Wagoner | Tarr | Durkee | Jennings | Nicholson

Marvin J. Bonnette has been added to the staff of **Maintenance Engineering Corporation** as a service engineer. His activities will center primarily on service of combustion-control and metering equipment, but he also will handle some sales.

Russell F. Clark has been selected as a sales and service representative for **Hammel-Dahl Company.** He heads his own firm, Russell F. Clark Company, in Pittsburg. The company will handle Hammel-Dahl sales in western Pennsylvania and parts of West Virginia.

William F. Burrows has been made general manager of a Diesel Engine division recently acquired by **The White Motor Company.** The division formerly was a unit of **The National Supply Company.** Burrows was in charge of the White Company's diesel activities in Cleveland.

M. H. Strickland, who has been representing **Builders-Providence, Inc.,** and **Proportioneers, Inc.,** in St. Louis, is now district manager of industrial sales for **B-I-F Industries, Inc.,** in Chicago, where he also will represent **Omega Machine Company.** He had held the post in St. Louis since 1936.

John Van Wagoner has taken over a new position in the Advertising department of **Wolverine Tube, division of Calumet & Hecla, Inc.** Formerly sales representative for Wolverine in Philadelphia, Van Wagoner has been with the company three years.

Alfred E. Tarr, formerly engineering sales manager for **Leeds & Northrup Company,** has been named as assistant to the president. Tarr, who has been with the company since 1919, served about 15 years as district manager in Chicago.

Rodney S. Durkee, chairman of **Lane-Wells Company,** has been elected a director of **Dresser Industries, Inc.,** and named a member of its Executive Committee. He joined Lane-Wells, recently acquired by Dresser Industries, as executive vice president in 1938 and has been president since 1939.

R. F. Jennings, formerly a plant superintendent for **Kerrigan Iron Works, Inc.,** has been advanced to director of safety and personnel. Previously connected with Carnegie Illinois Steel Company, he joined Kerrigan in 1948, starting as a foreman.

F. Clayton Nicholson, formerly director of chemical operations for **Davison Chemical Company,** has been elected vice president, with responsibility for operations at several of the company's chemical plants.

Wolverine Tube, division of Calumet & Hecla, Inc., has been awarded the Certificate of Public Achievement in the distribution and marketing classification, presented by American Public Relations Association. The award was given for out-

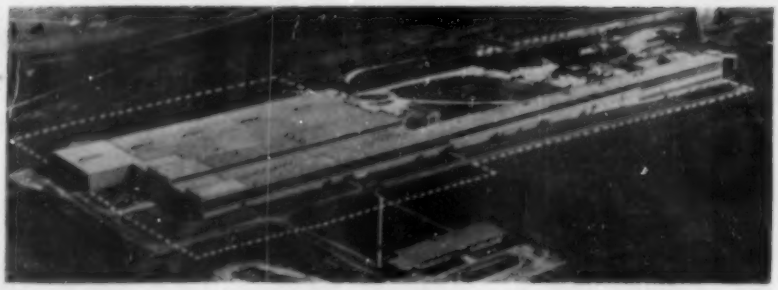
Suppliers . . .

standing service to plumbing, refrigeration and automotive wholesalers through an effort to promote a "Buy from Your Wholesaler" campaign. The company's winning entry will be made part of the new Archives of Public Relations in the Library of Congress.

Visco Products Company, Inc., has promoted D. M. Jacks and W. H. Kirkpatrick to vice presidents. Formerly assistant vice presidents of the Houston firm, both will continue in their present assignments. Jacks is sales manager and Dr. Kirkpatrick is technical director.

The International Nickel Company, Inc., has added a new man in the Electroplating section of its Development and Research division. He is Charles B. Sanborn, formerly senior research chemist in the American Steel & Wire Company laboratory at Cleveland. The section is concerned with the technical aspects of applying and using nickel coating.

Tod Pazdrel Pipeline Specialties has appointed F. A. Ford, former assistant chief engineer for Houston Pipeline Company, as a member of the sales engineering staff. Ford, joining the Topaz organization with 16 years experience in pipe-line, gasoline-plant and refinery construction, will assist in consulting, inspecting, testing and internal cleaning.



Expansion to Double Plant Capacity—

An expansion of the Armstrong Cork Company's fiberboard plant at Macon, Ga., is expected to double its present capacity and make it one of the largest fiberboard mills in the world, has been announced by Armstrong officials. Shown above is the original Macon Plant, completed in 1948, with broken white line to show the expansion plan. Architectural contracts have been let. Construction is expected to begin this summer, with completion of the expansion schdeduled for mid-1956.

Kaiser Steel Corporation will purchase the Steel division of Basalt Rock Company, Inc. The transaction, subject to the approval of stockholders in the Basalt company, will give Kaiser Steel an additional two modern plants in California, one at Fontana and another at Napa.

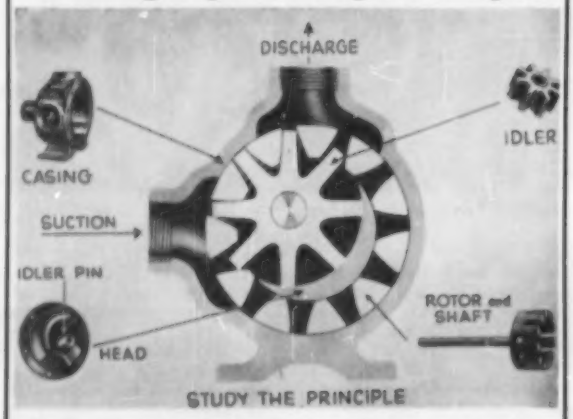
Production at the two plants would continue uninterrupted.

Childers Manufacturing Company will be represented in Oklahoma by John P. Dobbins Company, a Tulsa firm. Childers, a Houston company, produces a line of weather-proof coving used for insulation.

The Duraloy Company, a Scottdale, Pa., company, has been granted an exclusive license for the manufacture and sale of a new alloy known as Thermenol. The firm's territory will cover all the states east of the Mississippi River, together with Minnesota, Iowa, Missouri, Ohio, Arkansas and Texas.

Beckman Instruments, Inc., has appointed H. S. Schuler as advertising and sales-promotion manager. Formerly assistant general advertising manager for Westinghouse Electric Corporation, he had been an advertising executive with Westinghouse

Viking Operating Principle



Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

Distributors

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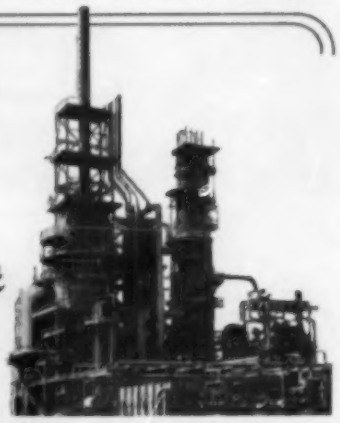
MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

Service Facilities at: Houston — Dallas — Kilgore — San Antonio Edinburg — Corpus Christi and Beaumont, Texas.

NO.1 in a series of ALUMICOAT APPLICATIONS

OIL REFINERY EQUIPMENT protected with *Alumicoat*



ALUMICOAT is a valuable industrial innovation that provides a metallurgical bond of pure aluminum and its alloys to steel! ALUMICOAT offers a firm resistance against chemical action and extreme temperatures especially important in oil refinery installations . . . resulting in a substantially improved process and longer life for the treated equipment.

Alumicoat can solve your corrosion and oxidation problems! Write for descriptive folder.

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PETROLEUM CHEMICALS DIVISION

NEWS

June ★ One of a Series of Interest to the Petroleum Industry ★ 1955

New TEL Plant to be built by Du Pont in California

A new convenience will soon be realized by West Coast refiners when the planned Du Pont tetraethyl lead manufacturing plant near Antioch, California is completed.

The rapidly growing TEL requirements of the West Coast petroleum industry prompted the Du Pont Company's decision to build the plant in the California location. The site is approximately two miles east of Antioch on the San Joaquin River. It is readily accessible to both water and rail transportation.

Construction of the new plant is expected to get under way this summer. In addition to the TEL manufacturing facilities, a "Freon" refrigerants plant will also be constructed on the same site.

9 out of 10 WANT it

. . . and your dealers can profit by offering it

Oil check is the most important dealer service, say 90% of the motorists interviewed in a survey of consumer service station buying habits.

But does a check of the dip stick really sell oil? Actual service station observations show that almost half of the motorists who receive it buy oil as a result of the check. Yet customers are offered an oil check on only 36% of their service station stops.

This means that your dealers can increase their motor oil sales simply by offering to check the dip stick for *every* customer. To help you emphasize this profitable point to your dealers, we have prepared a new booklet (No. 4) in the "Looking through the windshield" series. The title is, "A look at the motor oil buyer."

Ask one of our representatives for sample copies and cost information on obtaining them in quantity.

You can profitably expand your diesel fuel market with Du Pont FOA-2

In addition to their growing demands for more diesel fuel, the railroads are endeavoring to reduce operating costs. In order to meet these demands and maintain your profit margin, you may be faced with the problem of producing diesel fuel at lower cost.

That's a tough problem, to be sure. But it *can* be solved. And here's how Du Pont Fuel Oil Additive No. 2 can help you solve it, *profitably.*

You simply use Du Pont FOA-2 to stabilize your cracked distillate stocks. Its double-action stabilizing and dispersant effect enables you to overcome the incompatibility between blends of cracked and straight-run stocks.

And this means added production flexibility for you . . . helps you keep your heating oil stocks in better balance to meet varying seasonal demands.

Proven results

Many leading railroads are now using No. 2 fuel oils containing Du Pont FOA-2. And they have reported excellent results.

They have proved through careful testing that they can efficiently operate diesel engines on cracked distillates stabilized with Du Pont FOA-2 without harmful effects.

Good filterability

Because of its excellent dispersant action, FOA-2 improves the filterability of diesel fuels. In this way it helps to eliminate most injector-sticking and filter-plugging problems.

Non-sparking

Being an *organic, non-metallic* additive, Du Pont FOA-2 does not contribute to the exhaust stack sparking problem.

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED

Diesel Fuel Additive

Economical

Du Pont FOA-2 is extremely economical to use because it is effective in low concentrations. And you need no special equipment for adding it.

Test it yourself

Your fuel laboratory can easily test the effectiveness of FOA-2 in your own fuel oil stocks.

Free samples and complete technical information are readily available. Any Du Pont Petroleum Chemicals Division representative or regional office will be glad to supply them.

PHILADELPHIA DISTRICT MANAGER

LEWIS Z. CAREY is manager of the Du Pont Petroleum Chemicals Division's Philadelphia District, which serves the Delaware Valley area and the states of Maryland, Virginia, and North Carolina.

A graduate of the University of Delaware, he joined the Du Pont Company in 1941. He was a salesman in the Alcohol Division until 1950 when he was transferred to the Petroleum Chemicals Division as a sales-service representative.

Mr. Carey is vice-chairman of O.I.I.C. in New Castle County, Delaware and is active in both Delaware and Maryland O.I.I.C. activities.

During World War II, he served with the U. S. Navy.

HIGHLY SENSITIVE DEMONSTRATION ENGINE... to build dealer enthusiasm for your gasoline quality

Engine readings can be projected directly onto a screen for showings to large audiences. Or the unit can be set up on the back platform of a station wagon where the performance can be shown with the direct reading instruments.

Here is a brand new demonstration tool with an amazing talent for persuasion.

Gasoline quality may be one of the hardest things in the world to demonstrate clearly, even to dealers. But this new, single-cylinder engine setup can do it with superb showmanship. And if you want to turn a "doubting Thomas" into a satisfied customer, here's just the tool to do it with.

High compression engine

The unit is built around a single-cylinder engine with a 9.0 to 1 compression ratio. Other compression ratios are also available. With overhead valves and a hemispherical combustion chamber, it follows the latest design features of truly up-to-date automobile engines.

The engine is belted to an alternator and the power developed is dissipated in resistance grids.

Versatile

All types of combustion – normal, detonation and surface ignition – can be readily demonstrated with the unit. It can also be used to clearly demonstrate the wide variety of factors which influence knock – such as temperature, humidity, barometric pressure, spark timing, carburetor setting, etc.

Even wild ping and the various factors influencing surface ignition can be realistically shown.

Extremely sensitive, this engine will show up very slight differences in octane rating. And it is flexible enough to be adapted for tailor-made demonstrations to point up your own individual gasoline quality features.

Available soon

A number of these single-cylinder engine units are now being made and will soon be available to you on loan through any of our regional offices.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

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NEW YORK, N. Y.—1270 Ave. of the Americas. Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. Phone RAndolph 6-8630
TULSA, OKLA.—P.O. Box 730 Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. Phone BLackstone 1151
LOS ANGELES, CALIF.—612 So. Flower St. Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond Street, West, Toronto 1, Ontario
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Bldg., 6539—Wilmington 98, Del.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-9384

Printed in U. S. A.

Attend Concentrated Meeting—

Gathered at Chiksan Company's home office in Brea, California, for a concentrated three-day Sales Conference, April 18-20, were these men of the Chiksan Sales force. Front row, left to right: Jack Runnells, Chiksan of Canada, Edmonton; Joe Schlarb, Southern California; L. J. Smith, Eastern Regional Sales Manager, Newark; G. R. Winder, Vice-President and General Sales Manager, Brea; R. T. Jones, Western Regional Sales Manager, Brea; Bill Clark, Chicago; C. E. Thomas and Jack Powers, Newark. Second row: Frank Wiegand, Southern California; Bill Brien, Weco Division, Houston; Monk Cook, Southern California; Al Plomp, Chiksan of Canada, Calgary; Howard Dickson, Southern California; Lee Guill, Chicago; Chuck Holcomb, Weco Division, Houston; Bev Ragsdale, Chicago; Hal Stock, Oakland; and Art Edwards, Southern California.

18 years. He also had served as an account executive with Ketchum, Macleod & Grove, a Pittsburgh advertising agency.

Solvay Process Division, Allied Chemical & Dye Corporation has appointed **James E. House** as manager of its Detroit plant. At the same time, **William J. Bobek,** assistant manager in charge of personnel, was promoted to assume responsibility for plant operations.

Rockwell Manufacturing Company has changed the name of its Canadian subsidiary, Callander Foundry & Manufacturing Company, Ltd., to Rockwell Manufacturing Company of Canada, Ltd. The name was changed to reflect the operation of the Guelph, Ont., concern, which produces various Rockwell power-tool and meter products in addition to products originally manufactured under the Callander name.

Suppliers . . .

Rockwell Manufacturing Company has promoted Nelson E. Davenport, for the past five years a sales engineer in the Meter & Valve division's district office at Atlanta, Ga., to assistant gas products manager in Pittsburg. Davenport was with Taylor Refining Company before he joined the Rockwell Company.

Wolverine Tube, division of Calumet & Hecla, Inc., has completed a two-day seminar devoted to Wolverine Trufin, a company-produced condenser tube. Held in New York, the seminar was conducted by Dr. Donald L. Katz, professor of chemical engineering at the University of Michigan. Guests were engineers from the petroleum, petrochemical and refining industries in the East.

General Electric Company has named **Arthur H. Sisson** as manager of advance engineering in the Small Turbine & Supercharger department at Fitchburg, Mass. Formerly engineering administrator, Sisson is succeeded by **Richard A. Baker,** who was section supervisor of general accounts.

Sisson has been with General Electric since 1926, serving almost all his time with

GAUGE REPAIR

SAVE MONEY
FAST SERVICE

Our complete repair and overhaul service is of the highest quality. All work guaranteed and quick return assured. Let us keep your gauges and instruments accurate.

TULSA GAUGE AND INSTRUMENT CO.
1133 N. UTICA • TULSA, OKLA.

again MARK is FIRST
with *America's Finest*
STAINLESS STEEL UNIONS

"PETRO" 304-316

Feature Packed for Multiple Service on All Processing Where Stainless Steel Is Required

"PETRO" DUAL

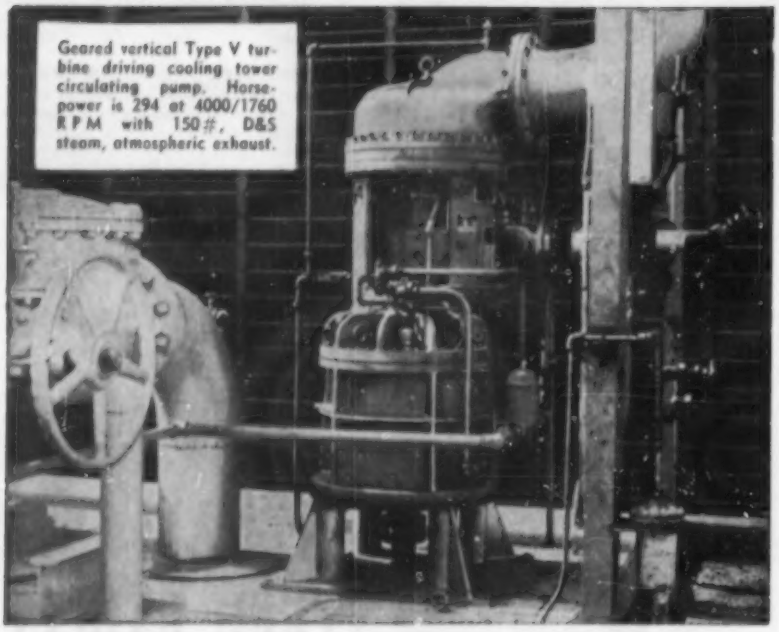
These unions are made with stainless steel ends and carbon steel nuts. Nut threads are permanently lubricated for easy make and break.

Drop forged from uniformly heated solid bars. . . . Finished to American Standard A.A.R. . . . Uniform wall thickness and concentricity maintained through quality controlled production. . . . Precision machined seats plus a differential in hardness form a perfect seal and will not seize at high temperatures. . . . Octagon shaped ends and nut provide safety from and resistance to distortion by wrench abuse.

A NEW CATALOG COMPLETELY DESCRIBES ALL OUR UNIONS . . . WRITE TODAY!

Clayton Mark & Company
1900 DEMPSTER STREET EVANSTON, ILLINOIS U.S.A.

Murray Turbines



Geared vertical Type V turbine driving cooling tower circulating pump. Horsepower is 294 at 4000/1760 R P M with 150#, D&S steam, atmospheric exhaust.

● Murray Vertical V turbines, both geared and direct-connected, are being used more and more for driving vertical pumps of all types. The Murray Vertical V turbine is designed from top to bottom as a vertical turbine, not just a horizontal turbine, "upended." The Murray Vertical is especially constructed and arranged for vertical mounting.

Murray vertical turbines can be furnished for steam pressures up to 600#, 750° F. TT. and back pressures as high as 100# and can carry most normal thrust loads imposed by vertical pumps.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

Suppliers . . .

the company in some phase of its turbine operations. Baker joined the company in its Shop Clerical section in 1942 and has been associated with the Small Turbine & Supercharger department's accounting force since 1946.

Boncher

Miller

Dresser Industries, Inc., has named two new operating vice presidents. They are H. P. Boncher, general manager of the company's Manufacturing division since 1942, and W. D. Miller, for ten years associated with Creole Petroleum Corporation in Venezuela.

Boncher will be succeeded as general manager by F. G. Fabian, Jr., who joined the company as his assistant in 1953. Fabian, previously with a Chicago firm of management consultants, joined Dresser with a background of 15 years in various engineering and managerial positions.

Assigned to the Manufacturing division since he joined the company in 1921, Boncher had been sales manager before he was moved up to general manager. In addition to his ten years in Venezuela, Miller spent 15 years in Mid-Continent production and pipe-line operations, seven years in sales and service with Dowell, Inc., and a period as a petroleum consultant to the Mexican government.

Davison Chemical Company, division of W. R. Grace & Company, has added two men to its Research & Development division. They are **Pierre F. Gunder,** who has been assigned to the Research Engineering department at the company's Curtis Bay Works in Baltimore, and **James A. Long,** assigned to the Development department at the company's Baltimore office.

Gunder previously had worked with the Design & Development agency for the Army Transportation Corps board and with National Lead Company. Long had been associated with Allied Chemical & Dye Corporation's Barrett division, Luken's Steel Company and W. C. Hamilton & Sons.

U. S. Steel Corporation has made a number of changes in the personnel of its field representatives. All the changes were in the corporation's Oil Well Supply Division.

Wesley Drummon Huston, a warehouseman at Edmonton, Alba., was named to represent the division in that area. Another change in the Canadian personnel was the promotion of **Kenneth J. Miller,** district merchandise manager at Edmonton who was promoted Canadian area merchandise

Suppliers . . .

manager at Calgary, Alba.

Transferred from Abilene, Texas, to Gainesville, Texas, as a field representative is **Joseph M. Rogers**, a veteran of 24 years in the oil and supply business. A storeman in Ventura, Calif., **Arthur Bernard Stonehouse** was promoted to field representative and transferred to Castaic Junction, Calif.

R. P. Mitchell, with the Oilwell division at Albany, Texas, since 1948, was made field representative. **John S. Purvis** was added to the Gulf Coast area organization as a representative at the Oilwell store in Brookhaven, Miss.

Wyatt Metal & Boiler Works has selected **E. F. Foster** as its manager of purchases, with headquarters in Houston. With Wyatt since 1945, Foster went to work in the Houston plant and later was transferred to the Purchasing department as an assistant to J. S. Gowdy, who has resigned. Foster previously had been connected with the Construction department of United Gas Corporation for 17 years.

Foster

Union Carbide & Carbon Corporation has elected Augustus B. Kinzel as vice president in charge of research, succeeding George O. Curme, Jr., who is retiring. Dr. Curme will continue as a director of the company.

Dr. Kinzel has participated in Union Carbide & Carbon research since he joined the affiliated Electro Metallurgical Company as a research metallurgist in 1926. He became chief metallurgist in 1931, was made vice president of Electro Metallurgical in 1944, and last year was appointed director of research for the Union company.

ALCO Products, Inc., has named **James J. Reynolds** as its new vice president in charge of operations. Formerly vice president in charge of industrial relation, he will be in charge of all manufacturing, procurement and material-control operations, as well as employe services and industrial relations.

A member of the National Labor Relations Board from 1946 to 1951, Reynolds left that post to become vice president of labor relations with U. S. Pipe & Foundry Company. He resigned that position in 1952 to become a management consultant and joined ALCO in 1953.

He is the brother of Quentin Reynolds, war-correspondent and author.

Kinney Manufacturing Division, The New York Air Brake Company, has appointed William B. Mills as assistant to its sales manager, Harold G. Saunders. He formerly was district manager at Philadelphia, and prior to that he was manager of the Cleveland office.

Succeeding Mills in the Philadelphia office will be Joseph P. G. Davis, formerly a sales representative in the Philadelphia

FOR VALVES IN CORROSIVE SERVICE

TEFLON* PACKINGS

BRAIDED TYPE

Refinery plants large and small have long been looking for a permanent acid-proof packing.

Up to now braided blue asbestos packing has been considered best and cheapest (60-day life). Today the whole world of packing has been changed by the material, "Teflon". Braided yarn packing made of Teflon is replacing all forms of braided packing for acid service because it lasts as long as the valve itself. Practically no acid, diluted or concentrated, hot or cold, has any affect on the packing. It is recommended for services at any pressure, with temperatures ranging from –100°F. to + 500°F.

"JOHN CRANE" Style 704 is available in handy coil or spool form in a full range of sizes from 1/8" to 3/8" square.

Many Petroleum Engineers are now using "JOHN CRANE" Style 704 Braided Teflon Packings for handling all types of corrosive liquids and gases. For the best in mechanical packings fabricated from braided Teflon, contact Crane Packing Company. *Send for this technical bulletin, containing important data and suggested applications for Teflon.* Crane Packing Company, 1820 Cuyler Avenue, Chicago 13, Illinois.

*Du Pont's trademark for tetrafluoroethylene resin.

JOHN CRANE CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

PRITCHARD LOUVERS MAKE POSSIBLE ICE-FREE OPERATION IN COLDEST CLIMATES!

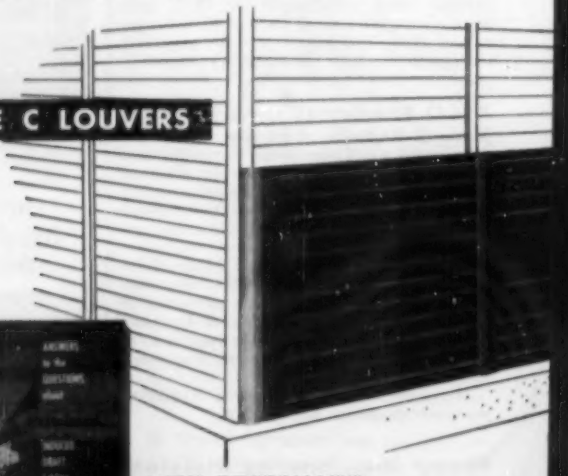
Ice formation on cooling tower louvers is a serious problem. Ice can break the louvers and also seriously damage the filling inside the tower. The tower is left inoperable—or, at best, operating inefficiently.

Before Pritchard developed Type WX louvers, there was no effective way of stopping ice formation or keeping the tower operating at peak efficiency in coldest weather. Operators of towers with ice-laden louvers shut off the fans—sometimes putting a canopy over the fan throat—in an effort to melt the ice. But the most they could accomplish was to prevent a further accumulation of ice. And often they couldn't prevent this. Then they tried reversing the flow of air through the tower. This did a partial job of getting rid of ice but also involved the purchase of costly reverse starters for the fan motors.

Now ice formation can be stopped before it starts—with the Pritchard Type WX louvers. One more reason to choose Pritchard!

TYPE WX LOUVERS

Especially designed to eliminate ice formation in extremely cold weather operation. Wide louvers are supported in a frame set out from the tower to prevent splashing water from reaching the louvers and forming ice. Each louver is individually hinged, can be opened or closed to regulate air flow into the tower, thus controlling water temperature and stopping ice formation. The WX louvers can be shut off on the windward side, leaving the louvers on the other side open. In this way the tower can continue to function efficiently without danger of freezing. The entire operation can be done from the ground, adding safety and convenience.



FOR TEMPERATE CLIMATES TYPE C LOUVERS

Louver boards are set at an angle on close centers vertically and are supported by slotted louver posts set close to the tower. All boards are individually removable for easy access to the basin. This design makes possible a neat, compact tower with minimum basin requirements.

INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

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OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
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NEW PRITCHARD INDUCED DRAFT COOLING TOWER BROCHURE

This new Pritchard brochure answers 15 questions about Pritchard Induced Draft Cooling Towers. Completely illustrated. Each feature described in detail. Large, cutaway drawing takes you inside a typical Pritchard tower. Interesting, informative. Send for your complimentary copy today on your company letterhead!

territory, and before that assigned to the Chicago area. Davis joined the Kinney organization in 1951.

Stratford Engineering Corporation has appointed Dr. A. R. Goldsby as director of research. With The Texas Company and its Texaco Development Company since 1936, he was concerned with research in fuels and development of the sulfuric-acid alkylation process.

Goldsby

Stratford recently was selected as agent for the sulfuric-acid process, and Dr. Goldsby will continue to be active in alkylation. Much of his time, however, will be devoted to the chemical industry.

At one time associated with National Aniline, he participated in the development of synthetic detergents. He also has been connected with National Aluminate Corporation.

National Aluminate Corporation has advanced three former assistant vice presidents to positions as vice presidents. They are H. R. Powers, given charge of sales for the company's Industrial division; Gage Averill, assigned to manage sales for the Catalyst division, and Alphonso Cantalini, who will continue as European manager, with headquarters in Rome.

Other promotions in the company include three new assistant vice presidents who will continue in their present assignments. They are H. E. Berg, manager for sales development; W. H. Thompson, product development manager, and A. O. Jaros, who is a legal advisor.

Koppers Company, Inc., has agreed to purchase the outstanding stock of American Aniline Products, Inc., fifth largest manufacturer of dyestuffs in the U. S. No change is planned in the corporate name, and the company will be operated as a wholly-owned subsidiary.

American Aniline has a plant in Lock Haven, Pa., a warehouse in New York, and laboratory-warehouse facilities in Providence, R. I.; Charlotte, N. C.; Chattanooga, Tenn.; Columbus, Ga.; and Chicago. Sales offices are maintained in Philadelphia, Los Angeles and Chicago.

Allis-Chalmers Manufacturing Company has elected Robert S. Stevenson as president. Executive vice president since 1952, Stevenson succeeds William A. Roberts, who recently died.

Stevenson started with the company in 1933 as a salesman in the Tractor division's branch office in Kansas City, and was transferred to the main offices in Milwaukee in 1936. In 1948, he was appointed assistant general sales manager for the Tractor division, and two years later was named general sales manager.

He was elected vice president in charge of the division when Roberts was moved up to president in 1951; later that year, he was made a director. He also serves as a member of the board's Executive Committee.

Ampco Metal, Inc., has four companies as its exclusive distributors in various sections of the U. S. They are Pacific Metals Company, Ltd., with offices in San Francisco and Los Angeles; McDonald & Wilson Sales Company, located in St. Louis; Miller Equipment Company, Cincinnati, and Red Arrow Sales Corporation, headquartered in Madison, Wis.

Minneapolis-Honeywell Regulator Company's Brown Instrument Division has named John M. Wilson as chief engineer for the Development & Design division in its Engineering department. Formerly chief electrical engineer for the parent company in Minneapolis, Wilson has been connected with its organization since 1933.

Suppliers . . .

Consolidated Chemical Industries, Inc., has elected three new vice presidents. They are Charles M. Hickey, Sam S. Emison and Jennings C. Crowder, all members of the company's Southern division headquartered in Houston.

Hickey associated with the company since 1924, will continue in Houston as manager of manufacturing for the division, and Emison, who joined the company in 1925, will stay on there as sales manager. Crowder, however, will be transferred to San Francisco where he will take over a newly-created position as general manager of the

ROBINSON

OLDEST NAME IN ORIFICE FITTINGS

Type E For Low Pressure . . .

2" to 30" A.G.A. Spec.

Where, except at Robinson, can you obtain all these features in an orifice fitting for gas or liquid flow? Extreme accuracy of measurement is yours because the Robinson orifice is always centered with the piping and sealed against leakage. Orifice plates can be changed safely and quickly (3 to 5 minutes) with no interruption in flow, no hazards or gas loss. Various sizes and pressure ranges up to 3,600 PSI, flanged or welding neck.

Type B For High Pressure . . .

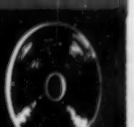
2" to 6" Pipe Size A.G.A. Spec.

Same fine metering characteristics as the standard low pressure Type E shown above, but built for 6,000 PSI with positive pressure seal which becomes tighter as the pressure increases. Safety is assured because the fitting cannot be opened until the pressure is released. Available in flanged or welding neck. Compare Robinson point-by-point and you'll choose Robinson.

SEND FOR ROBINSON CATALOG NO. 54.

ORIFICE PLATES AND HOLDERS

Standardize on Robinson orifice plates regardless of the make of fittings on your lines. Robinson plates conform rigidly to A.G.A. requirements. Our 30 year reputation for building accurate orifice plates is protection you can count upon.



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THE ONLY 90% METALLIC LEAD ALL-PURPOSE THREAD COMPOUND

AT NO EXTRA COST!

DRILLING ENGINEERS who first discovered "BIG D's" matchless sealing, lubricating, protective qualities wanted extra insurance for threads against heat and moisture. So, Dragert chemists fortified "BIG D" with the wonder-plastic SILICONE.

Now, at no extra cost, "BIG D" affords easier, quicker assembly and disassembly . . . easier, smoother application even when pipes are swimming in water.

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"BIG 'D' DOPE" is MONEY-BACK GUARANTEED to afford long-lasting ISLAND HIGH lead-plating protection to all threaded fittings. Warranted anti-wash-out, anti-gall, pressure-tight sealing under the most punishing pressures, temperatures, vacuums. Guaranteed to permit quick, easy, REPEATED make-ups and break-outs WITHOUT RE-DOPING.

FREE Sample Provides Positive Proof

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Please send me ☐ FREE brochure, "The Inside Dope on "BIG 'D' DOPE".
☐ FREE Sample of "BIG 'D' DOPE" for testing.

Name _____ Title _____

Company _____

Address _____ City and State _____

SERVING THE OIL INDUSTRY 15 YEARS

Suppliers . . .

New England and Pacific divisions. An employe of the company since 1927, he had been general superintendent in Houston.

Lukens Steel Corporation has appointed a manager for commercial development and launched an expansion into five new fields. Named to head the division which will direct the company's new phase of expansion is John A. Crowe, former manager of market research for Westinghouse Electric Corporation. Initially, the company will be interested in entering the plastics, contractors' equipment, highway supplies, pleasure boats and do-it-yourself fields.

Alan Wood Steel Company has elected **Harleston R. Wood** as president and chief executive officer. He succeeds **John T. Whiting**, president since 1939. Whiting, who has served as chairman of the board since 1941, will continue in that position.

Wood

Wood had been vice president in charge of planning and development. He joined the company in 1938 and served in a variety of positions in the metallurgical and operating departments before he was named to supervisory posts in the Planning & Development department.

E. I. DuPont de Nemours & Company, Inc., has elected **Samuel Lenher**, assistant manager of its Organic Chemicals department, to posts as director, vice president and member of the Executive Committee. His successor as assistant general manager has not been named.

During his 26 years with the Du Pont organization, Lenher has been engaged in research, production, sales, and more recently, administration. He also has taken an active part in the affairs of the chemical industry and currently is serving as president of the Synthetic Organic Chemical Manufacturers Association.

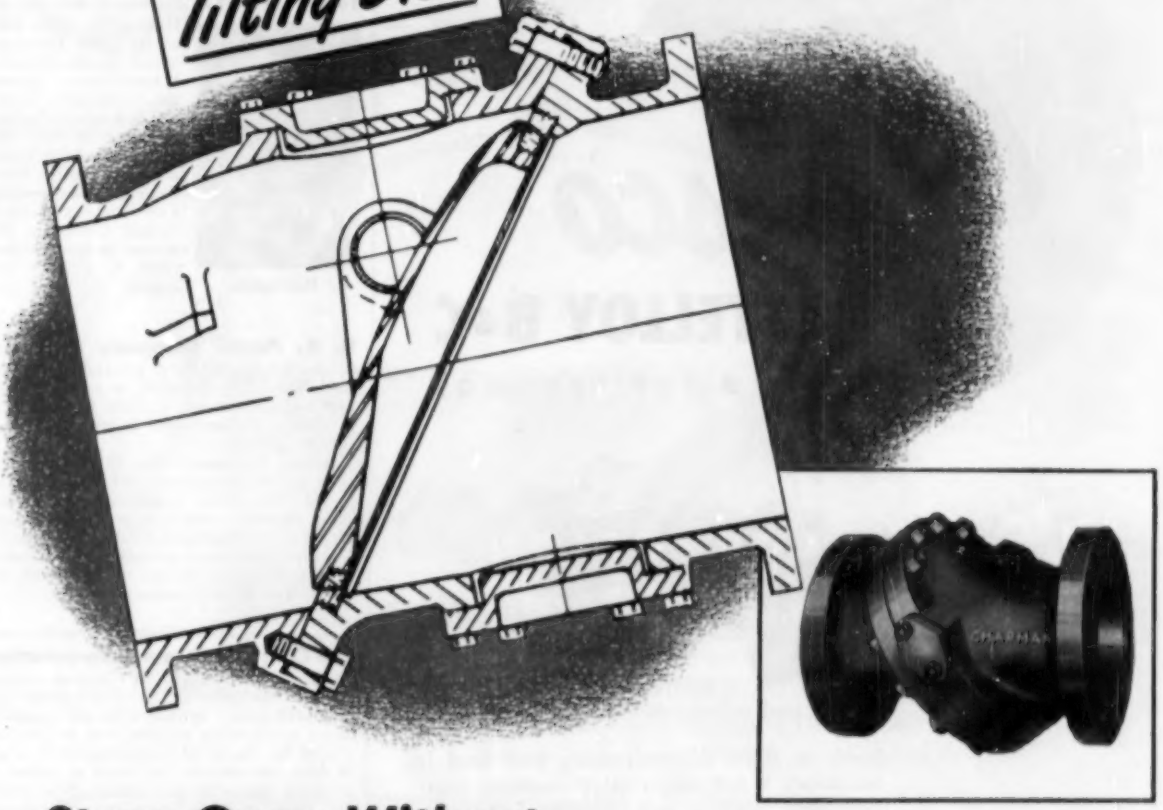
Du Pont Company's Gresselli Chemicals department has gone into commercial operations at its East Chicago Works with the world's largest single unit for the production of sulfuric acid. Capable of turning out more than a trainload of acid a week, the new contact unit represents the latest step in a long-range modernization program designed to increase the company's sulfuric-acid manufacturing facilities.

American Cyanamid Company has named **Howard R. Huston** as a consultant, following his retirement from a post as vice president and director. He became vice president in 1951, and was elected director in 1952.

Huston joined the company in 1930 as assistant to the president. Earlier, he had

CHAPMAN'S
CHECK VALVE

Tilting Disc



Stays Open Without Flutter, Closes Fast Without Slamming

Chapman's Tilting Disc check valve keeps maintenance costs down in the entire piping system. There's no flutter or vibration in the open position: the lightweight, airfoil-designed disc is held firmly against its stops by the fluid flow.

When flow starts to reverse, the uniquely designed disc swings quickly to the closed position, cushioned by fluid pressures, and then drops to a tight seal against the seat, without sliding or scraping. Closure is fast, tight . . . and *quiet*. Slamming is *eliminated*, in all but unusual piping arrangements.

Freedom from vibration and slamming, low wear and low head loss keep maintenance costs down, give years of more efficient service. For every check valve service, specify Chapman's Tilting Disc. Available in steel or iron, with suitable trim to meet service conditions. Full engineering data are in Catalog 30. Write for it today.

The Chapman Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.

Look to *ESCO* for everything you need in Hastelloy B & C super alloy castings. Conventional, Shellcast and centrifugal castings are available to meet your most exacting requirement. You get prompt delivery—even on small orders.

Hastelloy fittings are available from stock—standard flanged, screwed and welded fittings can be delivered fast from conconveniently-located warehouses.

THE TOUGHEST CORROSION PROBLEMS WIND UP AT . . .

Look to *ESCO* for everything you need in stainless and high alloy steels. Ask our high alloy engineers to make a complete study of your corrosion problems. Call your nearest *ESCO* office for details.

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Other Offices and Warehouses
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San Francisco, Calif.
Seattle, Spokane, Wash.
Houston, Texas
Eugene, Oregon
Salt Lake City, Utah
Honolulu, Hawaii

In Canada: Vancouver, British Columbia and Toronto, Ontario.

Suppliers . . .

been a member of the Secretariat of the League of Nations, a post to which he was appointed in 1919 by President Woodrow Wilson.

Tube Turns has appointed **Edward F. Harrington** to the staff of its Sales Development department. Harrington joined the company's Product & Engineering department in 1954. He previously had been connected with Worthington Corporation and International Supply Company. He served both organizations as a sales engineer.

Harrington

H. K. Porter Company has named C. I. Young, a vice president of its Laclede-Christy Division, to serve as general manager for the division. He had been in charge of operations at seven Laclede-Christy plants.

Young had more than 30 years experience in the refractories industry when he joined the Porter organization. He had been asistant to the vice president for operations with Harbison-Walker Refractories Company and more recently, was executive vice president in charge of operations for Union Fire Brick Company.

The Cooper-Bessemer Corporation has appointed **Dwight R. Craig** as administrative assistant in its Engineering department. Craig started with the company as an engineering trainee; was project engineer in charge of a photographic study of fuel combustion, and after a period as research engineer was advanced to assistant chief research engineer, the position he held until his present promotion.

H. K. Porter Company, Inc., has made M. J. Ross export-trade manager for two of its divisions, Quaker Rubber Corporation and The Watson-Stillman Company. Previously export manager for Quaker Rubber, Ross now also will handle

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Since 1915
CONCRETE
SAND AND CEMENT
"Placed by Air"

We have a well-trained and experienced field organization. We own and operate 43 complete cement gun outfits.

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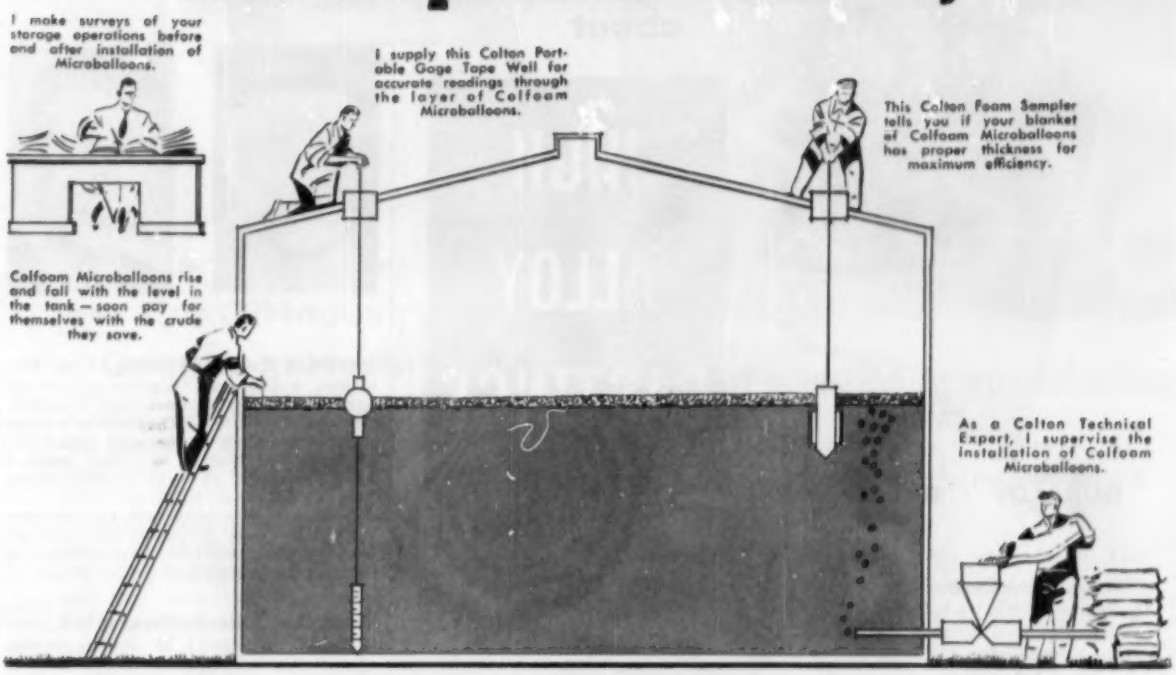
Colfoam Microballoon* blanket cuts evaporation losses by 86%


I make surveys of your storage operations before and after installation of Microballoons.
I supply this Colton Portable Gage Tape Well for accurate readings through the layer of Colfoam Microballoons.
This Colton Foam Sampler tells you if your blanket of Colfoam Microballoons has proper thickness for maximum efficiency.
Colfoam Microballoons rise and fall with the level in the tank — soon pay for themselves with the crude they save.
As a Colton Technical Expert, I supervise the installation of Colfoam Microballoons.

Plus These Extra Savings Exclusive with Colton

Lower-cost Conservation of Crudes and Products
Surveys . . . Installations . . . Control Systems

Costly losses of crude oil stored in cone-roof tanks can now be effectively controlled by at least 86% with approximately a ½ inch covering of Colfoam Microballoons.

"Bought by the pound and used by the fraction of an inch" accurately describes Colfoam Microballoons. Because they are lighter than other materials, it takes less pounds for a blanket . . . therefore saves dollars on the original investment.

Urea formaldehyde Colfoam Microballoons are exclusive with Colton Chemical Company and are microscopically-small, gas-filled spheres which float on top of stored crude oil and form a foam-like seal.

Colton Chemical Company believes that manufacturing and selling Colfoam Microballoons is not enough. For this reason Colton Technical Service "on the job" is available at no cost to all users of Colfoam Microballoons. Specifically, this means surveys before purchase to estimate what savings can be effected and how much material is needed. It means supervised installations and "follow through" surveys to determine actual savings. Helpful instruments are supplied—a Portable Gage Tape Well assists in accurate readings of the amount of crude stored and a Foam Sampler measures foam thickness. Complete Technical Bulletins are supplied and control systems for maximum efficiency are recommended by Colton Technical Experts—all at no additional cost.

Savings in stored oil are now possible with Colfoam Microballoons. For full information fill in the coupon below and mail today.

*COLFOAM Reg. T. M., Colton Chemical Co. MICROBALLOON Reg. T. M., Standard Oil Co. (Ohio)

COLTON CHEMICAL COMPANY

COLTON

A Division of Air Reduction Company, Inc.
1545 East 18th St. • Cleveland 14, Ohio

Sales Offices and Warehouse Facilities also in New York City; Chicago; Elkton, Md.; Spartanburg; Dallas; Seattle, Portland; San Francisco and Los Angeles

Colton Chemical Co., 1545 E. 18th Street, Cleveland 14, Ohio

Send sample of Colfoam Microballoons, technical bulletins, specifications and "on the job" servicing information.

☐ Crude Oil ☐ Products

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Organization_____

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16 pages of useful information about

HIGH ALLOY CASTINGS

DURALOY DURASPUN

This is our New General Bulletin—3354G. It's full of information and data on the chrome-iron and chrome-nickel castings so necessary when corrosion, high temperatures and abrasion must be resisted. It will serve as a general selection guide for those specifying or using such castings.

The bulletin also reviews briefly our experience in both static and centrifugal castings, an experience going back to the pioneering days of 1922 and 1933 respectively. It also tells about our facilities for furnishing castings to any desired analysis, welding, X-ray and gamma ray testing, metallurgical and foundry control.

WRITE or CALL our nearest office for a copy.
We believe you will find it helpful in your work.

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OFFICE AND PLANT: Scottdale, Pa.
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Suppliers . . .

the hydraulic presses and equipment produced by Watson-Stillman. Before joining Quaker, he was manager of Firestone International's Industrial Rubber Products division.

Nickel

Olson

Peerless Pump Division, Food Machinery & Chemical Corporation, has appointed two new product sales managers. They are Carl L. Nickel, named to manage the sale of water systems and dealer-line products, and Norman C. Olson, assigned to handle the sale of engineered-line products.

Both men have been with the company since 1946. Nickel previously was a product sales manager, and Olson was manager of the company's branch office in Chicago.

Canadian Allis-Chalmers, Ltd., now is headed by Harold M. Schudt, former vice president who has been promoted to the company's top position. He replaces Mark C. Lowe who resigned after being president of the company since 1951 and associated with Allis-Chalmers Manufacturing Company's Canadian affiliate since 1947.

Schudt, who joined the Allis-Chalmers organization in 1929, was named sales manager for the Canadian company in 1947 and two years later was elevated to vice president. During World War II, he was on loan to the Canadian government, which placed him in charge of administrating capital equipment and electrical products.

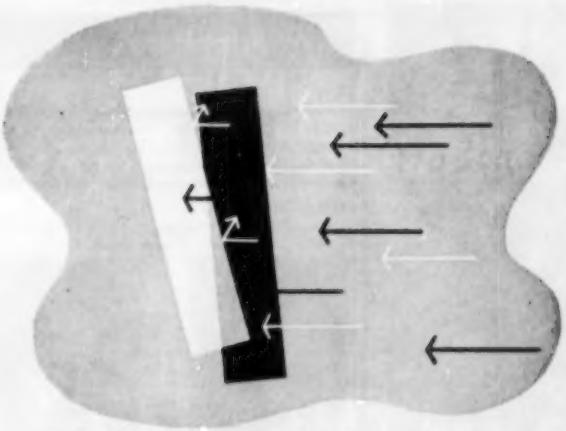
Insul-Mastic Corporation of America is transferring its home office from Pittsburg to the office building at its plant in Summitt, Ill., a Chicago suburb. The company's sales and manufacturing divisions will be located together to produce better coordination.

Du Pont Company's Petroleum Chemical division has released a 17-minute movie showing seven common causes of engine knock, ranging from poor driving habits to altitude changes. The 16-millimeter movie disproves the average motorist's idea that poor gasoline quality is the only cause of engine knock.

The Girdler Company has appointed Earl Englert to a newly-created position as manager of catalytic sales for its Gas Processes division. Girdler is a division of National Cylinder Gas Company.

With Girdler since 1950, Englert was a

For more data on advertised products, use Readers' Service Cards, last page.



Radioisotope Laboratory For Oil Industry Opened in Houston!

A radioisotope laboratory solely for supplying the petroleum industry with special tagged compounds has been opened in Houston at 2419 South Boulevard by Tracerlab, Inc. The laboratory will stock and ship on 24-hour notice all the short lived isotopes and standard tagged chemicals now being extensively used, and will thus overcome present serious delivery problems.

Tracerlab has been supplying compounds to oil companies for several years from its Boston, Massachusetts and Richmond, California laboratories. The growing volume of orders has made it practical to establish a special laboratory in a location more convenient for the majority of users.

Many standard compounds utilized by the oil industry are to be packaged and sold under the firm's trade names: TraceSols, which are radioisotope solutions or volatile or gaseous compounds; and TraceOids, which are radioactive isotopes in the form of particulates. These compounds can be shipped on 24-hour notice or less, if the ordering firm's general authorization from the Atomic Energy Commission is on file.

Descriptive sheets on TraceSols and TraceOids, complete with specifications, prices and illustrations of some of the applications, are available on request.

HOUSTON LABORATORY
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BUT FAST—that's how old coats of paint roll off when you strip tanks the quick, money-saving Oakite way.

Powerful Oakite strippers, applied by hot-flow-on, steam-gun, or cold-flow-on method, actually float off paint, dirt, and grease—right down to the base metal. You save time . . . no hand scraping, chipping or blasting. You save money . . . long-life solution may be reclaimed and reused. And you're safe . . . no fire hazard.

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FW cooling tower
serves huge atomic plant

Now in service at a large Atomic Energy Commission plant, this 44-cell cooling tower designed and built by Foster Wheeler has a rated capacity of more than 150,000 gallons per minute. Covering an area of approximately 46,500 square feet, it is one of the largest cooling tower installations ever made.

Foster Wheeler cooling towers reflect more than 50 years of experience in meeting the specific requirements of all types of power and process plants. Each tower is engineered and constructed to give maximum performance at minimum cost.

For complete information on FW cooling towers, send for your complimentary copy of Catalog CT-52-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

Suppliers . . .

member of the Engineering department until 1952 when he was assigned to the company's New York office as a sales engineer. He previously had been connected with Monsanto Chemical Company in Dayton, Ohio.

Odell

Martin

James Bute Company has elected two new vice presidents. They are **Glynn F. Martin**, the company's sales manager for the past several years and now its vice president in charge of sales, and **Loren B. Odell**, technical director of the company's research laboratories and manufacturing plant since 1945.

Union Asbestos & Rubber Company has moved the Sales department of its Fibrous Products division to a new office building adjacent to the company plant in Bloomington, Ill. The department formerly headquartered in Chicago.

The new offices will be in a building recently completed at Bloomington. Other company units scheduled for housing there are the division's Production Control and Specification departments.

Union Carbide & Carbon Corporation has named **Farnsworth L. Jennings** as director of its Law department. An officer in several of the corporation's divisions and subsidiaries, Jennings has been a member of its legal staff since 1935.

The Pfaudler Company has moved the offices for its Southwest region from Dallas to Houston. Serving the region as representative is **A. G. Anderson.**

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FOR SALE **FOR SALE**

JUST PURCHASED!

Complete Compressor Station

6—I-R KVG-6 gas engine compressors, 600 & 660 hp complete with accessories

$50,000 new spare parts

2—I-R Starting Compressors, Model 25-C, explosion-proof motors

3—100# vessels, 10′ x 20′, 6′ x 20′, 8′ x 16′

6—Centrifugal pumps, 2000 GPM, 90′ hd; 400 GPM, 290′ hd; 60 GPM, 460′ hd.

6—M. W. Kellogg 2400 sq. ft. ADM heat exchangers

PRICED FOR IMMEDIATE DISPOSAL—WRITE, WIRE, PHONE

Liquidation—Levelland, Texas

6′ x 58′, Chrm. lin. tower, 20 tray, 50#, mfgd. '51

6′-6″ x 55′; 6′ x 27′; 5′ x 27′; 42″ x 49′; 30″ x 35′ steel towers

5—ADM heat exchangers, 1600, 500 sq. ft.

2—800 sq. ft., 675# 800° F heat exchangers

5′ x 40′ Chrm. lin. 90# vessel

4′ x 40′ 325# vessel

BJ 5 stage NiCh 400 GPM, 2000′ hd steel & chrome pipe, valves, fittings and many other items

Equipment Elsewhere

7′ x 26′—SS, 10 tray, 50#

7′-6″ x 56′, 30 tray, 45#

2′ x 60′, 560#

5—300# vessels, 8′ x 30′, 7′ x 30′

1—Gould 16″ pump, 15,000 GPM, 135′ hd.

2—Pacific 6 stg., 730 GPM, 2000′ hd

6—715 sq. ft. Atmos Ht. Exchs. ADM

10—Steel heat exchangers, 1500, 360, 260 sq. ft.

30—Atmos Ht. Exchs. 715, 477, 108 sq. ft.

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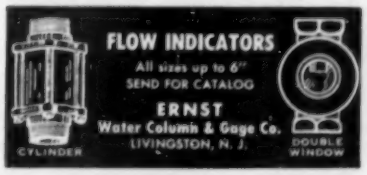

■ FOR SALE: Surplus Walworth Limitorque Motor Control Valves, 4″ thru 18″. Details furnished on request. Write, wire or phone Purchasing Agent, Texas City Refining, Inc., P. O. Box 1271, Texas City, Texas. Ph. 5-4461.

PROFESSIONAL SERVICES

■ JOHN J. HARTE CO., Engineers • Construction Managers—Petroleum • Agricultural Chemicals • Gas Transmission • Reforming • By-Products • Surveys • Complete Plants. 284 Techwood Dr., Atlanta, Ga. • New York • Washington • Houston • Foreign

EQUIPMENT WANTED

■ Manufacturers Representative 10 years experience wants lines for sale to Oil, Gas, Chemical industries in New York area. Box 196-R, c/o Petroleum Refiner, Houston, Texas.

HELP WANTED

OPERATING ENGINEER
NEW YORK OFFICE

To assist in supervising office & field and domestic & foreign activities of the Operating Department.

Challenging opportunity for graduate chemical or mechanical engineer with minimum five years petroleum refining experience, preferably with contracting engineering firm.

Please airmail confidential verifiable chronological resume, including salary history, to

PERSONNEL Department

HYDROCARBON RESEARCH, INC.
115 Broadway New York 6, N. Y.

STAFF ENGINEER

Major operator of gasoline plants has staff opening for qualified process, design and construction engineer. Requires supervisory experience and ability to direct major programs. Must have engineering degree with minimum of ten years experience in the field of gasoline plant design and construction. Salary commensurate with experience and qualifications. Age limit 40.

Send detailed personal and work history with photograph to Box 194-R, c/o Petroleum Refiner, Houston, Texas.

Position available
for a

PROJECT MANAGER
at the
M. W. KELLOGG CO.

. . . a position with the career potential only a top-ranking firm can offer. The man who fills it will be the "job architect" supplying the technical information required for design and development of oil refineries and chemical plants . . . lending his extensive experience to every phase of the project . . . and maintaining considerable liaison work with the customer.

A degree in chemical or mechanical engineering with 8 to 10 years' diversified experience in the petroleum and chemical industries are minimum requirements. The right man for the job will know the others, in terms of initiative, ability and personality.

Interested persons should send complete details, including salary requirements, to Mr. R. L. Stacom.

M. W. KELLOGG CO.
225 Broadway
New York 7, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

Managerial Personnel Needed

FOR RESEARCH CENTRE IN THE PETROLEUM INDUSTRY

Ente Nazionale Idrocarburi (E.N.I.) has under its supervision a number of Italian Companies active in the field of petroleum and petrochemicals. ENI's major activity is centered in the following items:

—gas and oil field exploration and exploitation (current production: 105 billion cu. ft. of natural gas per year);

—operator of a 2500-mi. pipe-line system (capacity over 700 million cu. ft. per day);

—owner and operator of a tanker fleet of around 120,000 dwt;

—owner and operator of an extensive network for distribution of petroleum products and LP-gas throughout Italy (64 Bulk plants, 4000 stations, etc.);

—control over or shareholding in refineries having a processing capacity of about 6 million tons of crude oil per year;

—owner of factories (1500 employees) for construction of machinery;

—shareholding of chemical plants (700 employees) for production of synthetic dyes, detergents, etc.;

—under construction, a petrochemical plant (production capacity—30,000 tons per year of synthetic rubber and 350,000 tons per year of ammonium nitrate).

E.N.I. is organizing a big research centre for investigation and development of petroleum processing and manufacture of petrochemicals. Some departments are expected to begin operation next summer.

Italian or foreign technical experts, with a wide educational background, specific training, organizational and managerial ability, are required to fill positions as heads of the main departments of the laboratories.

Specifically the following are sought:

1) Chemist or physicist with specific knowledge and experience in thermodynamic and chemico-physical problems;
2) Chemist specialized in the preparation of organic compounds, particularly those derived from hydrocarbons;
3) Inorganic chemist soundly and completely acquainted with modern methods of of experimentation, research and testing;
4) Engineer or industrial chemist specially trained in the methods for improving petroleum products applications;
5) Engineer or physicist, with physico-technical and technological training, specialized in the problems of thermo-technics, measurements and controls;
6) Engineer or industrial chemist with extensive research experience in the field of crude oils processing;
7) Engineer or industrial chemist particularly experienced in extending laboratory procedures to pilot plants;
8) Engineer with good theoretical knowledge and laboratory experience in engine tests on fuels and lubricating oils;
9) Engineer or industrial chemist specially trained both in theory and practice in the fields of corrosion and protective means for materials.

Note: University degree mandatory.

Applications should state age and other usual personal data, educational background and qualifications, practical experience, etc., and should include a photograph. Please address personally to the **Presidente dell'Ente Nazionale Idrocarburi, Via Lombardia, 43—Roma—Italy**, with the special note **RISERVATA PERSONALE** (i.e., to be opened by addressee only).

Absolute discretion in every respect is assured.

Salary offered will be in accordance with position, training and qualities required.

PROCESS DESIGN ENGINEER

If you have a degree in chemical engineering and 5 to 10 years of diversified process design experience in petroleum and chemical industries, and are interested in a process design position with a future, you should consider joining the McKee organization.

Please send complete personal details including salary requirements to:

Edward A. Kolner
ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
CLEVELAND 1, OHIO

Chemical Engineer

Progressive petroleum refinery in Houston area has opening for graduate engineers. Prefer five years industrial experience including three years process design experience in petroleum refinery.

Responsibility will be the solution of interesting and varied process design problems arising in refinery.

Your reply will be held confidential. Send complete resume, including telephone number, to:

P. O. Box 5698, Harrisburg Station, Houston 12, Texas.

CHEMICAL ENGINEERS

Graduates with minimum 3 years' process design experience in oil refinery or surface oil producing facilities. For New York office. Must, however, be willing to relocate in foreign operation at some future date.

Also Chemical, Mechanical and Electrical Engineers with comparable or related experience are needed for process and project work in Arabia. Assignments and salary commensurate with experience and training.

Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 23
ARABIAN AMERICAN OIL COMPANY
505 Park Avenue
New York 22, New York

PROCESS ENGINEER

Experienced in design, engineering and supervising operations of carbon black plant employing oil black process.

Interviews arranged on basis of complete chronological resume, including education & employment (names & addresses of employers, dates employed, salaries received, positions held, including your specific duties & scope of responsibility).

All replies are confidential.

Box 199-R
c/o Petroleum Refiner
Houston, Texas

— CHIEF — ESTIMATOR

To head-up estimating section in chemical engineering company. At least 10 years experience in estimating petroleum and/or chemical plant costs. Excellent opportunity in growing young firm. Write salary and full particulars to:

(Mail Box No.)
201-R, c/o Petroleum Refiner
Houston, Texas

— ENGINEERING — EXECUTIVE

To supervise project engineers in chemical engineering company. At least 15 years experience as a petroleum and/or chemical plant project engineer. Excellent opportunity in growing young firm.

Write salary & full particulars.

(Mail Box No.)
200-R, c/o Petroleum Refiner,
Houston, Texas

THE STANDARD OIL COMPANY (OHIO)

Manufacturing (Refining) Department

is looking for

CHEMICAL ENGINEERS, CHEMISTS, and MECHANICAL ENGINEERS

with one to five years experience in petroleum refining or related activities

for staff work primarily in Cleveland, Ohio.

Possible employment in Toledo, Lima, or Cincinnati, also.

Applicant should have the following educational background and industrial experience:

Chemical Engineers: B.S. or higher degree and experience in development, pilot plant operation, process design, process trouble shooting, refinery process engineering, economic studies, or related work background.

Chemists: B.S. or higher degree and experience in product and process research or development.

Mechanical Engineers: B.S. or M.S. degree and experience in process equipment construction, design, inspection, or maintenance, petroleum product testing and field evaluation, or related work background.

Age range 22-32

Salaries commensurate with experience and level in organization. Advance on merit basis.

If you can qualify and are looking for a permanent job with a growing but secure midwest company, write, giving full information on education, industrial experience, military experience, and personal data to E. G. Glass, Jr., 1737 Midland Building, Cleveland 15, Ohio.

ENGINEER

Position in Houston with growing process industry construction company.

Work will include: Estimating, Project Engineering and Coordination, Pipe and Vessel Design, and Field Engineering and Supervision.

Projects are varied and interesting.

Preferred background:

2-10 years experience in above fields and Mechanical or Chemical Degree.

A man who can grow with the company will receive preference.

Replies will be kept confidential. Mail resume including description of experience and salary requirements to:

Bellco Industrial Engineering Company

P. O. Box 2132, Houston 1, Texas

CHEMICAL ENGINEERS

LOW TEMPERATURE PROCESSING PROCESS—PROJECT—DEVELOPMENT DESIGN—SALES ENGINEERING FIELD SERVICE, ERECTION AND TEST

Excellent opportunities are available to a few carefully selected engineers in each of the above general categories in the field of low temperature process, including air separation, ammonia production, processing of refinery and coke oven gases and other complex low boiling point mixtures for the chemical, petrochemical and metallurgical industries. These permanent salaried positions offer excellent opportunity for advancement to engineers of proven background in a rapidly expanding field. All negotiations confidential. Submit resume to AIR PRODUCTS, INC., P. O. BOX 538, ALLENTOWN, PA., PERSONNEL DEPT.

HELP WANTED

pressure vessel designers

Educational and practical background in forces and stresses. Men who can handle other than standard methods of design. Shop experience and welding knowledge desirable. Reply fully to: **C-29, P. O. Box 3414 Phila., 22, Pa.**

MECHANICAL ENGINEER

Can You Qualify For This Exceptional Opening?

ME degree, 10 years' experience in chemical, petroleum or allied fields of process plant design, capable of full responsibility for overall arrangement, as well as selection and/or design of the principal components of process plants.

This senior staff position requires exceptional ability. It represents an unusual opportunity to join an established organization on the East Coast with an international reputation of achievement and integrity.

If you possess these qualifications, this may be the job for you. Write full details, including salary history, in complete confidence. Box No. 198-R, c/o Petroleum Refiner, Houston, Texas.

Petroleum Refiner

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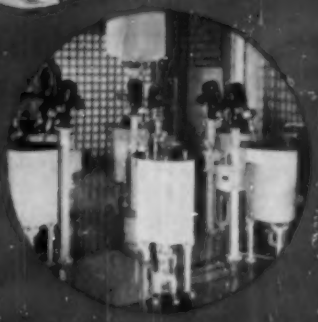
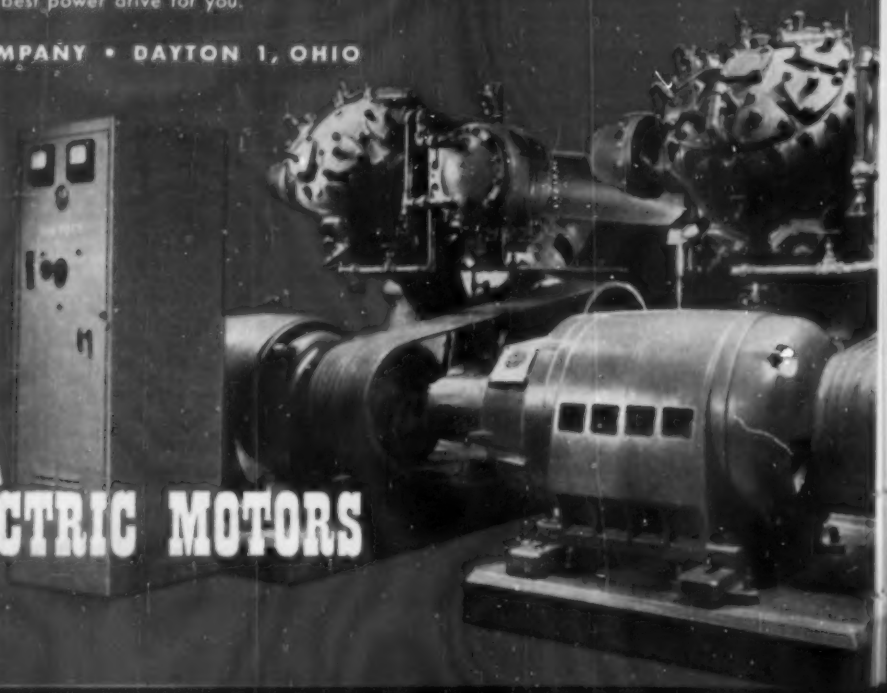


What do you need in your electric motor drives . . . gear reduction . . . electric brakes . . . variable speed operation . . . fluid drive . . . special mountings or does a standard motor (like the 200 HP synchronous motor shown below) best suit your needs? Whatever it is, check with Master first. We offer you the widest selection of electric motor drives in the nation.

In thousands and thousands of ratings, ⅛ to 400 horsepower . . . in open, enclosed, splash proof, fan cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 430 to 1 ratio . . . with either magnetic or dynamic type electric brakes . . . with fluid-drive . . . with mechanical or electronic variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best power drive for you.

it's easy to get the right results

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



MASTER

ELECTRIC MOTORS

What's New In Equipment . . .

Moderately-Priced Computer Solves Complex Problems

An electronic computer, moderately priced, and capable of solving the lengthy and complex problems of research and engineering organizations is now in production at the Bendix Computer Division of Bendix Aviation Corporation.

The computer incorporates an improved two address command structure which permits greatly increased versatility. The commands provide for addition, subtraction, multiplication and division, as well as branching and other logical operations.

Standard input and output devices furnished with the computer include an electric typewriter, a photo-electric tape reader and a mechanical tape punch. Accessory magnetic tape units are available for additional storage or input and output purposes. Auxiliary equipment is also available to permit the use of punch cards and an incremental graph plotter.

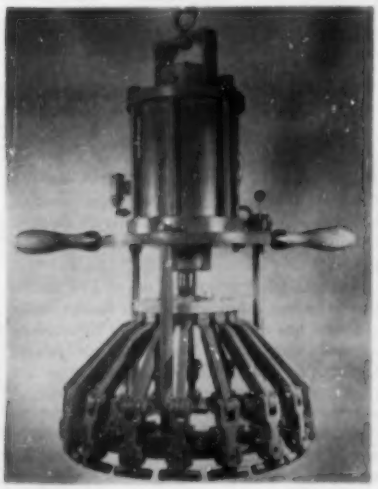
Maintenance requirements have been cut by employing etched circuits and by packaging electronic circuitry in plug-in units.

For the information you need on this new, high performance, compact computer, simply . . .

Circle E1 on Postcard

A new portable, heavy-duty crimping unit has been announced by Barrett Manufacturing Company.

Designed for sealing the universal standard 120# lug cover drum, the new unit, Model PMC-3U, can be used in tight places where it is not feasible to cut into conveyors with their standard portable complete crimping machine. The moderate cost of the PMC-3U permits a faster payout and makes it practical for the medium volume packager.



The new unit is an overhead suspended crimping head, directly connected with a 6-inch double acting air cylinder, complete with valves and handles. While the new unit is of the same heavy duty construction as the standard Barrett Automatic and Manual crimpinig machines, its weight is only 180 pounds. It can be installed with either a counter balance rig or a balancing unit.

For the information you need concerning this new crimping unit in your operations, just . . .

Circle E2 on Postcard

A new submersible pump motor, designed to operate safely while immersed in high-octane gasoline, has been announced by the General Purpose Component Motor department of General Electric Company.

The result of thousands of hours of engineering research and field testing, the motor has been slimmed down to fit inside a three and one-half inch gasoline pipe.

BURRELL

"For Scientists Everywhere"

ANNOUNCES

THE KROMO-TOG®

For Analysis by Gas Chromatography

A simplified quantitative method of analysis is used—based on the differences in adsorption affinity of the components in a mixture.

Typical Applications Include:

- Separation of closely boiling isomers including liquid hydrocarbons.
- Analysis for trace components.
- Routine, rapid control analysis for control component.
- Propane in commercial butane.
- Fixed gases in hydrocarbons such as nitrogen in natural gas.
- Analysis of organic acids, alcohols, ketones, aromatics, esters and other classifications of organic liquids.
- Particularly suitable for separating closely boiling compounds and determining specific components in complex mixtures.

EXTREMELY VERSATILE . . . .

THE KROMO-TOG AND ACCESSORY APPARATUS PROVIDES THE LABORATORY WITH ALL BASIC INSTRUMENTATION FOR GAS CHROMATOGRAPHY

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Manufacturers and Distributors of
SCIENTIFIC APPARATUS and LABORATORY CHEMICALS

New Equipment . . .

Since it was early discovered that it would be impossible to keep gasoline from seeping into the motor, it is designed to be flooded with gasoline—the fluid acting as a coolant and bearing lubricant. The windings and stator core are protected from ill effects of the gasoline by being completely sealed in an impervious epoxy resin material. For added motor protection and fire safety, a thermostat is provided which disconnects the motor from the line shortly after the bulk tank is pumped dry.

The motor is rated at ¾ hp, 230 volts, 60 cycle, 3450 rpm. It will absorb a 50-pound thrust, when the pump thrust is away from the motor. This new motor has been inspected and approved by Underwriters' Laboratory.

Complete details are available now.

This item supplements General Electric Company data on Pages 442-443 of The Refinery Catalog, 22nd Edition.

Circle E3 on Postcard

Valves for super critical temperature applications have been developed and are now being manufactured by Edward Valves, Inc., a subsidiary of Rockwell Manufacturing Company.

These valves, rated for 7,250 psi at 700 F. or 10,800 psi at room temperature, are the result of many years research on valve behavior in the Edward laboratories. While these valves were developed primarily for use in steam power plants employing temperatures above the critical temperature, they should find many applications in the refining, natural gasoline and petrochemical industries.

Complete details are available now.

Circle E4 on Postcard

A magnetic starter 40 percent smaller than previous models of the same ratings, has been announced by General Electric Company's General Purpose Control Department.

Designed for motors of up to 100 horsepower rating, the new starter is the same size and has the same mounting dimensions as the size 3 model. Strongbox coil design includes a tough, cast-on plastic case for maximum protection of coil windings. A permanent air gap causes the starter to drop out when de-energized regardless of age and usage, and a new type of bimetallic overload relay provides overload

...like having a Buell dust collection system

An exaggeration? We invite you to see for yourself! Just ask us for the name of the Buell customer nearest you!

Thanks to Buell's scientific dust collection equipment . . . many of America's Leading Corporations recover up to 40 tons of re-usable dust daily! You'll be amazed to see how soon Buell equipment pays for itself . . . how much in extra profits it brings in . . . how little it costs to operate.

Besides absolute proof of performance from customers . . . Buell offers you a unique "no risk" plan whereby you can determine *in advance* the *profit potential* of a Buell installation for your plant.

Now's the time to get the facts . . . and start the ball rolling. We'll send you our booklet—The Collection and Recovery of Industrial Dusts—which explains *all three* Buell systems of industrial dust collection. We know that both you and your engineers will find it most interesting and profitable reading. Write Dept. 21-C, Buell Engineering Company, 70 Pine Street, New York 5, New York.

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MECHANICAL ELECTRICAL

20 Years of Engineered Efficiency in

DUST COLLECTION SYSTEMS

For more data on advertised products, use Readers' Service Cards, last page.

HOW YOU BENEFIT WITH GIRDLER CATALYSTS

Increases ammonia output 40% with

GIRDLER G-29 CATALYST

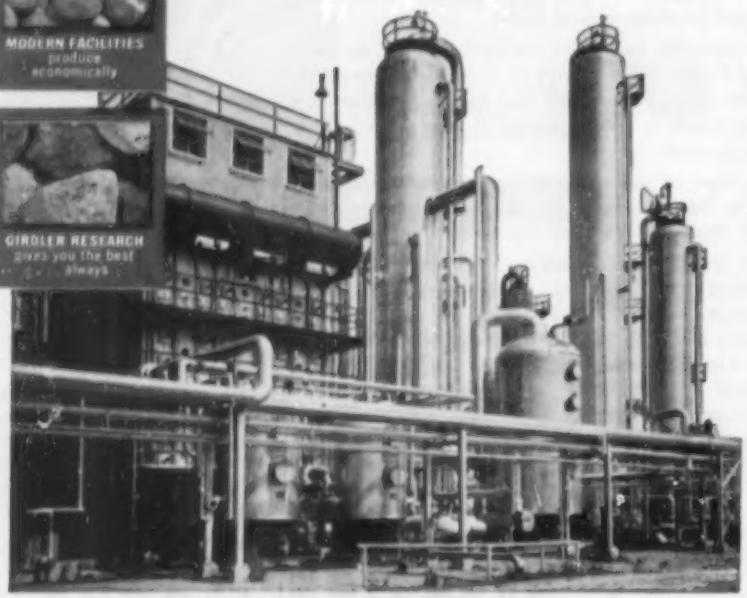
at Mississippi Chemical Co., Yazoo City, Miss.

APPLICATION: Promoting reaction of steam, air and natural gas in reforming furnaces to produce ammonia synthesis gas.

TECHNICAL SERVICE of Girdler demonstrated that a switch to its newly developed G-29 would result in an appreciable increase in the ammonia production.

RESULTS: Greater activity of G-29 enables customer to increase ammonia production about 40% when required. This is accomplished with no appreciable increase of fuel consumption per unit of ammonia produced.

Find out how Girdler Catalyst Technical Service can help *you!* Write for Bulletin G-260.



the GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

GAS PROCESSES DIVISION: New York, San Francisco
VOTATOR DIVISION: New York, Atlanta, Chicago, San Francisco
In Canada: Girdler Corporation of Canada Limited, Toronto

New Equipment . . .

protection comparable to that available in smaller sizes.

This new NEMA size 4 starter is available in reversing, multi-speed, and combination forms, and can be obtained with either vertical or horizontal mechanical interlocks. It is suitable for operation of polyphase motors in ratings up to 220 volts-50 hp and 440/550 volts-100 hp.

Complete details are available now.

This item supplements General Electric Company data on Pages 442-443 of The Refinery Catalog, 22nd Edition.

Circle E5 on Postcard

Control valves for sodium, potassium, and similar molten metal and high temperature services, are now in production by The Annin Company.

Designated model series 1401, the body rating of the new line is 150 psi at 1600 F. Valves can be furnished in body sizes ½ inch through six inch, with a choice of Annin Company's Domotor, cylinder or manual operators. A variety of end connections are also available.

Complete details are available now. Simply . . .

Circle E6 on Postcard

A new vinyl mastic protective coating that requires only a one-coat application has been developed by Amercoat Corporation. It can be applied at a thickness of ten mils in one double-pass spray coat, and produces a heavy film thickness without sacrificing vinyl chemical and moisture resistance. The coating is applied with conventional industrial spray equipment. It

DELIVERY AT YOUR CONVENIENCE

This Draw Bench Makes it Possible

Along with the advantages of full forging properties and good design flexibility obtained with B&W Hollow Forgings, assurance of prompt delivery is important.

The B&W Hollow Forging process permits an almost unlimited mix of sizes and analyses to be produced concurrently with small loss in set-up time and tool changes. Thus, small quantities can be processed for quick delivery —even to single length orders.

Further, the wide size availability allows the designer to work closely to his optimum designs, which results in savings in both weight and cost.

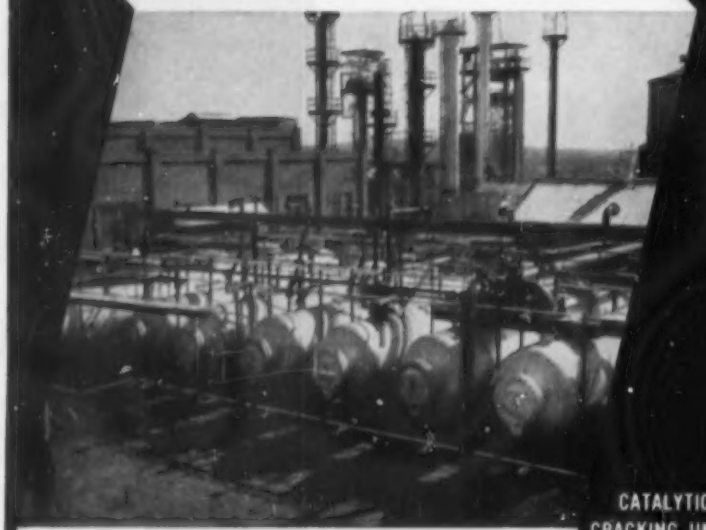
The B&W Hollow Forging process provides a combination of values that users of large diameter, heavy-wall pipe and tubing would do well to consider, and avail themselves of. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX
BOILER DIVISION

S-449

For more data on advertised products, use Readers' Service Cards, last page.

A Controlled Fire Hazard



CATALYTIC CRACKING UNITS

FRACTIONATION SECTIONS

PUMPING STATIONS

Count 'em – seven propane storage tanks – a potential disaster area for most petroleum properties. Not so at this large refinery though. "Automatic" FIRE-FOG is ready at all times to detect and extinguish the smallest blaze before it becomes a large one – before it shuts down operations, damages equipment, reduces profits.

Many installations of ENGINEERED "Automatic" FIRE PROTECTION have been made in refinery and petro chemical properties throughout the Western Hemisphere and the record speaks for itself: "Complete control of fire within protected areas – in seconds!"

If you're the one responsible for plant safety and continuity of production, we'd suggest an early review of your fire hazard safeguards. Then, whether your needs call for protection by means of "Automatic" Sprinklers, water spray, chemical or mechanical foam, carbon dioxide, or dry powder, we'll gladly provide, at no cost to you, preliminary engineering service. Through this you'll be able to evaluate the economic and adaptability features of each method of protection for your own risk.

PUMP ROOMS

EXTRACTION UNITS

BUTADIENE TANK FARMS

Write or call us today for an appointment with a "Safety First" future.

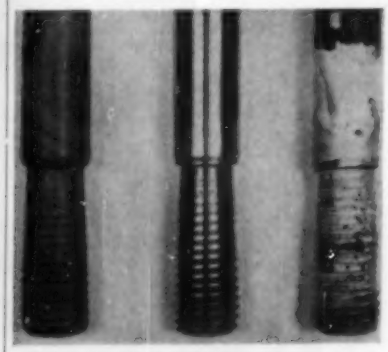
"Automatic" Sprinkler CORPORATION OF AMERICA
YOUNGSTOWN, OHIO

Offices in Principal Cities of North and South America

New Equipment . . .

also reduces the possibility of edge corrosion because its heavy, impervious film provides a corrosion resistant barrier around edges and sharp objects which always have been trouble spots in industrial maintenance painting.

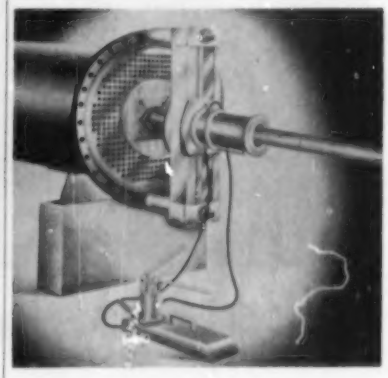
New properties of the coating are the



result of an increased vinyl resin content made possible by new combinations of solvents.

Above, bolt on left has one coat of primer and one coat of the No. 87 vinyl mastic. Center bolt is uncoated to show surface detail. Bolt on right has three coats of a good vinyl coating. Both coated bolts were exposed to severe salt spray test for the same period of time.

Circle E7 on Postcard



A hydro-ejector for the removal and the replacement of heat exchanger bundle tubes has been developed by the Fabricated Products Division of M. W. Kellogg Company. This new device eliminates the need for "jerry-built" rigging and pulling beams. It also reduces the usual safety hazards presented by such rigging, and can be operated by only two men.

The hydro-ejector is attached directly to the exchanger shell, no temporary steel structures are required to withstand the powerful thrust (12,000 pounds force can be exerted by the device). None of the removal force is transferred to the exchanger supports.

This new device which is available from Kellogg as a complete packaged unit, in-

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Photomicrograph of stress-corrosion cracks in Admiralty tube. (Mag. 500 times).

Stress Corrosion Cracking Shortens Tube Life Needlessly

Properly selected condenser tubes subject to normal corrosion will generally give long, economical service. Tubes subject to corrosion plus stress will sometimes fail prematurely. Analyzing the causes of stress corrosion shows this type of tube failure can often be prevented.

Causes of Fatigue and Corrosion Fatigue Cracking

Perhaps the most common cause of condenser-tube stress is vibration. A pulsating vapor or fluid entering at high velocity can set tubes vibrating at their resonant frequency. Nearby rotating machinery such as turbines, pumps, fans, motors, etc., can have the same effect. Repeated vibratory flexing strains, if prolonged and severe enough, will result in the formation of transcrystalline cracks eventually extending through the tube wall. The protective film of normal corrosion products is broken, and the corrosive medium seeps into the cracks, further weakening the tube metal by its attack.

Areas of greatest stress from vibration occur close to the tube supports, where the sharpest bending takes place. Here, and less frequently midway between supports, from a few to a hundred tiny transverse cracks will form in the tube wall. Just one crack can eventually cause failure.

If the tubes are closely spaced, vibration may bring them into contact with each other, abrading their outer surfaces. Tube vibration can take place without being noticeable outside the exchanger shell. Its only indication may be abrasion marks on tubes found during routine inspection, or tube failure itself, suffered during operation.

Vibration can be damped by wedging strips of wood or flattened tube pieces between the affected rows of tubes. Additional tube supports is another, more expensive though more satisfactory answer. If nearby machinery is causing the vibration and it is feasible to do so, the critical speeds can be avoided, thus eliminating the vibration.

Stress Corrosion or Season Cracking

Another common cause to tube stress that can lead to stress corrosion cracking is over-rolling tubes into tube sheets. A little extra care in tube rolling may prevent this happening. Sometimes another more resistant tube alloy or frequent cleaning of the tubes is needed. Stress can also be set up in tubes by such factors as high operating pressures, restrained thermal expansion and contraction, or by bending, flattening or denting tubes by rough handling. Good design and, again, reasonable care are the answers. Residual stress in tubes as supplied by the manufacturer is seldom significant, thanks to modern annealing practices.

That stress of any cause may contribute heavily to tube failure has been graphically proved in the Bridgeport Corrosion Laboratory, where constant research is at work for you. Tests show that, in the absence of stress, no cracking has occurred. On the other hand, stress did promote cracking in certain solutions or vapor, notably ammonia or mercury.

Causes of Corrosion

The most destructive corrosion in stress cracks is caused by traces of ammonia and mercury. Ammonia is usually generated through decomposition of organic matter during shutdown or low-velocity operation. Mercury sometimes enters the system as mercury salts, present in certain crude oils, or as free mercury from measuring or control devices. The combined action of oxygen and moisture and ammonia is needed to produce stress-corrosion cracks.

The best way to keep ammonia from forming is to keep exchangers clean and dry during shutdowns or to use chlorination during operation to prevent slime accumulation. Be careful of chlorination, though. In concentrated amounts, it severely attacks copper and copper alloys.

The Role of Alloys

In general, when stress is likely to occur unavoidably in the presence of ammonia and mercury, the proper choice of alloy is the most effective solution. Copper is the most resistant metal to stress-corrosion cracking, followed closely by 70/30 Cupro Nickel, and then by Red Brass, Aluminum Bronze, (Duronze IV), Admiralty, Muntz and Aluminum Brass.

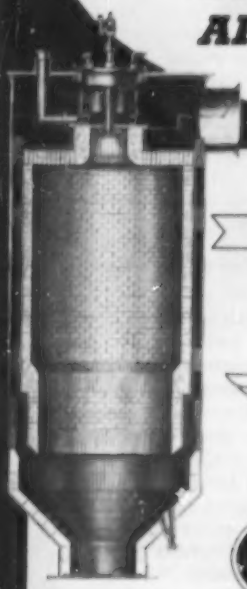
If stress corrosion cracking is costing you money and loss of production, ask Bridgeport Technical Service to analyze the factors involved and recommend the alloy best suited to your operating conditions. We have successfully solved many such problems in a wide variety of applications. Call your nearest Bridgeport Sales Office for a copy of the Bridgeport Condenser Tube Handbook. This 165-page volume has a wealth of valuable information for users of condenser tubes. (2155)

For more data on advertised products, use Readers' Service Cards, last page.

The Leaders...

***know and use* PEABODY**

DIRECT FIRED AIR HEATERS



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76

• Peabody Direct Fired Air Heaters are engineered designed and built to meet individual job specifications in the petroleum refining industry.

They are available in a complete range of pressures and firing rates from 1,000,000 BTU/hr upward.

For complete information on these custom engineered Air Heaters, write for Bulletin 600A.

OFFICES IN PRINCIPAL CITIES

PEABODY
ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK 36, N.Y.

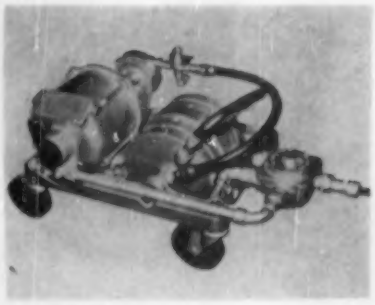
PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

New Equipment . . .

cluding pump, hose, adjustable yoke, ram, tie rods, cable and accessories, should prove of value to the maintenance departments of all refineries.

Complete details are available now.

Circle E8 on Postcard



A new hot sprayer for vinyls, and other organic finishes is now available from Spee-Flo Company. Called the Circaflow 600, the new unit is equipped with a ¼ hp explosion proof motor and a new "coil-less" design which eliminates clogging and restricted heat transfer.

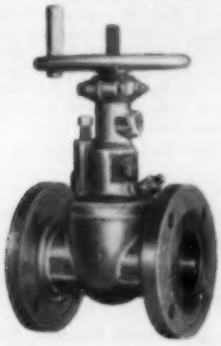
UL approved and factory set at 160 F. the new unit is designed to maintain heat reduced material at the spray gun at a capacity of 15 gph and at distances up to 50 feet from the heater, for wide mobility. Low maintenance cost is one of the main features of the new unit, Circaflow 600, which is completely without bearings, gear pumps, or other close tolerances.

A booklet "Why Hot Spray?" as well as details on this new unit are available from the company now. Simply . . .

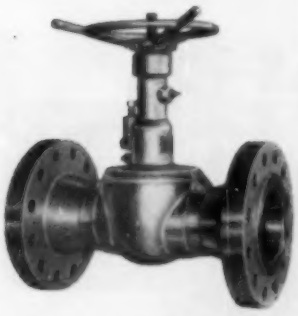
Circle E9 on Postcard

An electrical impulse contactor that can activate open-close electrical circuits at a varying rate up to 1500 times per minute has been introduced by Rockwell Manufacturing Company. This device is designed to actuate electronic and electromagnetic

ORBIT VALVES HOLD



Full Round Opening Flanged End, Sizes: 1", 1½", 2", 2½", 3", 4".



Venturi Opening Only Flanged End, Sizes: 2", 2½", 3", 4", 6".

Screw End—full round opening. Sizes: 1", 1½", 2", 2½", 3", 4".

HYDROCARBONS

- NATURAL GAS
- ETHANE
- PROPANE
- BUTANE
- ETHYLENE
- PROPYLENE
- BUTADIENE
- BENZENE
- TOLUENE
- XYLENE

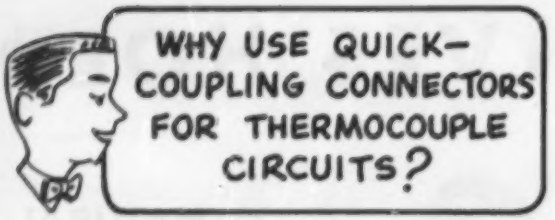
ORBIT VALVES ®

See 22nd Edition of Refinery Catalog for full particulars on Orbit Forged Steel ASA Class valves or write for Catalog 55-B.
A good range of sizes are available beginning with 1"

ORBIT VALVE COMPANY

P. O. BOX 699 *(For over 40 years)* TULSA 1, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

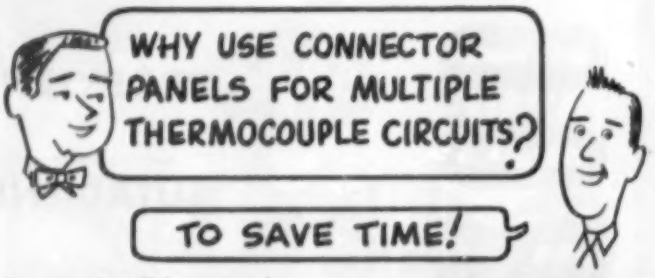


Frequent making and breaking of thermocouple circuits can take a lot of costly time. However, if you use T-E plug-and-jack connectors, a circuit can be made as quickly and easily as plugging in a radio.

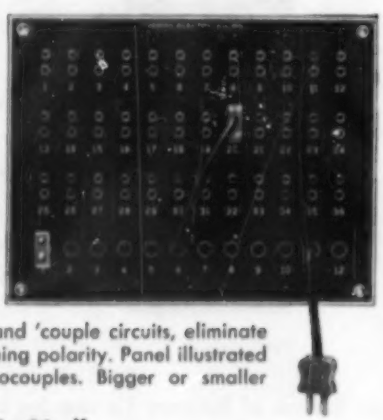
Electrical contact is established through polarized elements which are made of thermocouple materials (your choice for use with Iron Constantan, Copper Constantan or Chromel Alumel Thermocouples). To maintain good electrical connection, the mated plug and jack provide both long-wiping surfaces and spring-loaded contacts. The connectors have screw-fastened, insulated covers, colored and marked to indicate calibrations.

PAT. PEND.

Interested? Write for Bulletin 23–X.



By connecting all thermocouple circuits through central points, such as T-E's connector panels, you can save time in 2 ways. (1) Check instruments or thermocouple circuits from one or more centrally located distribution panels. With plug-and-jack connectors, test instrument is easily and quickly tapped into any circuit. (2) Transfer multiple thermocouple circuits. The panel's quick-coupling connectors permit rapid making and breaking of instrument and 'couple circuits, eliminate splicing time and avoid mis-matching polarity. Panel illustrated takes 12 pyrometers, 36 thermocouples. Bigger or smaller panels, if you want 'em.



Interested? Write for Bulletin 23–X.

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

New Equipment . . .

counters, predetermining counters, totalizers, recording printers, sampling devices and devices for injecting additives.

The device may be attached to any Rockwell liquid meter used in the refining, natural gasoline, and petrochemical industry. The unit activates an open-close electrical circuit at intervals proportional to the number of units measured by the meter, such as gallons, barrels, etc.

Some of the features of this new contactor are:

- Ball bearing mounted shafts.
- Removable cast-aluminum housing.
- Explosion-proof, externally mounted switch.

Complete details are available on this new instrument now.

This item supplements Rockwell Manufacturing Company data on Pages 633-640 of The Refinery Catalog, 22nd Edition.

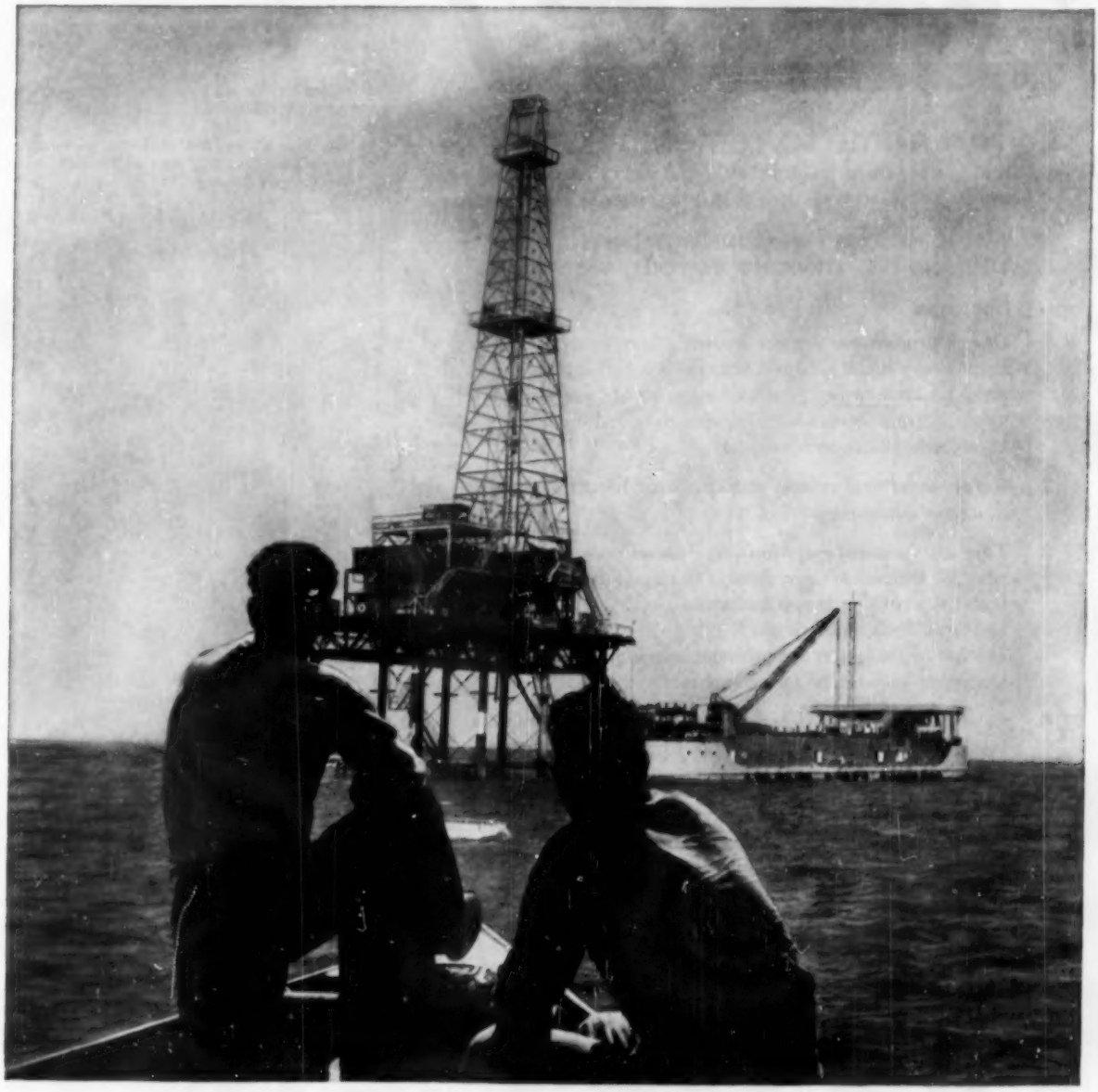
Circle E10 on Postcard

A magnetic liquid level gauge designed for use in the refining, natural gasoline and petrochemical industry has been announced by Rochester Manufacturing Company, Inc. Called CRITERION, this new, heavy duty gauge can be easily modified to make it suitable for I.C.C. vertical cylinders, horizontal cylindrical tanks and spheres, for above or below ground service.

To supply maximum strength at the point where float arm movement is transmitted to the shaft, an oversize, protective shroud carries the gear segment, thus preventing injury in installation or by rough handling. Gear teeth are designed for rolling contact so that no foreign matter will wedge into the teeth.

The new Criterion snap-on dials (the

GOING PLACES *deep-sea fishing with Cities Service...*



Cities Service, fishing for oil and gas in the waters of the Gulf of Mexico, last year brought in a record catch of liquid petroleum. Cities Service "anglers" are now fishing the deepest waters yet, in search of even more gas and oil, to meet the needs of its fast-growing customer family.

CITIES SERVICE

A Growth Company

For more data on advertised products, use Readers' Service Cards, last page.

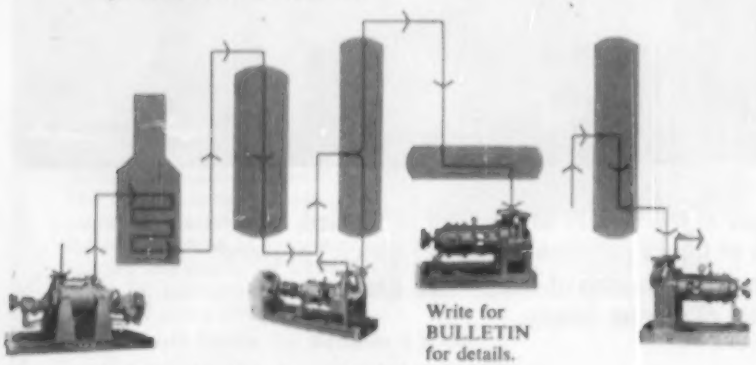
PACIFIC®

The name to remember when your problem is to start the charge stock and to keep it and its fractions moving without interruption on their guided tour through your process unit.

PACIFIC PROCESS PUMPS INSURE MORE SERVICE FOR YOU AND LESS SERVICING BY YOU

because

1. ***Design proportions are not limited*** to "just enough." ***Extra heavy metal sections,*** identical bolting for glands and seal plates are combined with selected materials of construction to provide that "extra margin" needed to extend use life in corrosive-erosive services.
2. ***Guided inlet flow*** reduces prerotation and friction losses ... insures minimum required NPSH.
3. ***They are balanced—dynamically—radially—axially—eliminates—*** vibration that would cause damage to rings ... bushings ... bearings ... packing or mechanical shaft seals ... excessive radial and thrust loads on bearings. ***Increases***—availability for profitable operation. ***Decreases***—down time for maintenance.
4. ***Positive lubrication of bearings***—oil rings pump oil up into bearing cap from where it must flow through—not around—the bearings back into the oil reservoir—contributes to trouble free operation ... longer bearing life ... low maintenance.
5. ***Labyrinth seal*** in each bearing cap ... no contact between shaft and seal ... keeps oil in and dirt out of bearings—prevents contamination of lube oil—contributes to trouble free operation—low maintenance.



Write for BULLETIN for details.

Custom Designed, Engineered and Manufactured by:

PACIFIC PUMPS INC.

One of the Dresser Industries

HUNTINGTON PARK, CALIFORNIA

Offices in all Principal Cities

CP-13

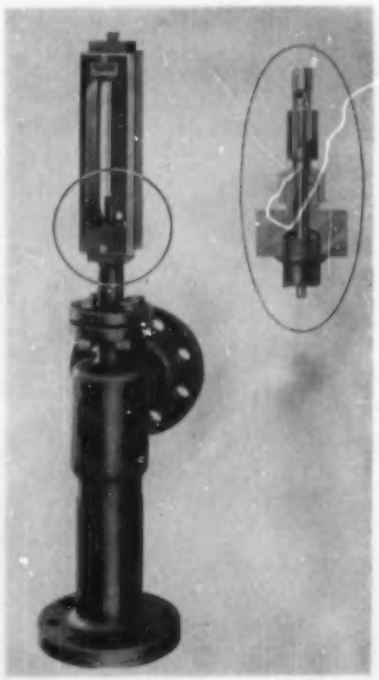
New Equipment . . .

same size used for both junior and senior models) permit quick field replacement of a damaged dial without removal of the entire gauge. Dials are hermetically sealed, making them submersible and moisture proof.

Complete details are available on this new gauge. Simply . . .

This item supplements Rochester Manufacturing Company, Inc., data on Page 774 of The Refinery Catalog, 22nd Edition.

Circle E11 on Postcard



A non-magnetic extension tube replaces the customary glass tube in the new "Mag/Na/Vue" which has been developed mainly for use with the Brooks Armored Rotameters. The unit is designed for use at pressures to 1200 psi at 200 F. or for metering opaque fluids.

Riding inside the extension is a float with a permanent magnet imbedded in the float head. Outside the extension a lightweight indicating sleeve moves in response to any change in float position. The magnet in the float head holds the sleeve in permanent bond to the float position. The extension is sealed in place by a "Swagelok" tubing connector integrally machined as a part of each end fitting. No o-rings or rubber packings are required. This sealing principle eliminates many maintenance problems, and permits simplified assembly and dis-assembly.

For complete information, simply . . .

Circle E12 on Postcard

JOB 1012

A Complete Integrated

Fertilizer Plant

designed and now being constructed

by CHEMICO for

Escambia Bay Chemical Corporation

at Pensacola, Florida ★

to help America produce better crops

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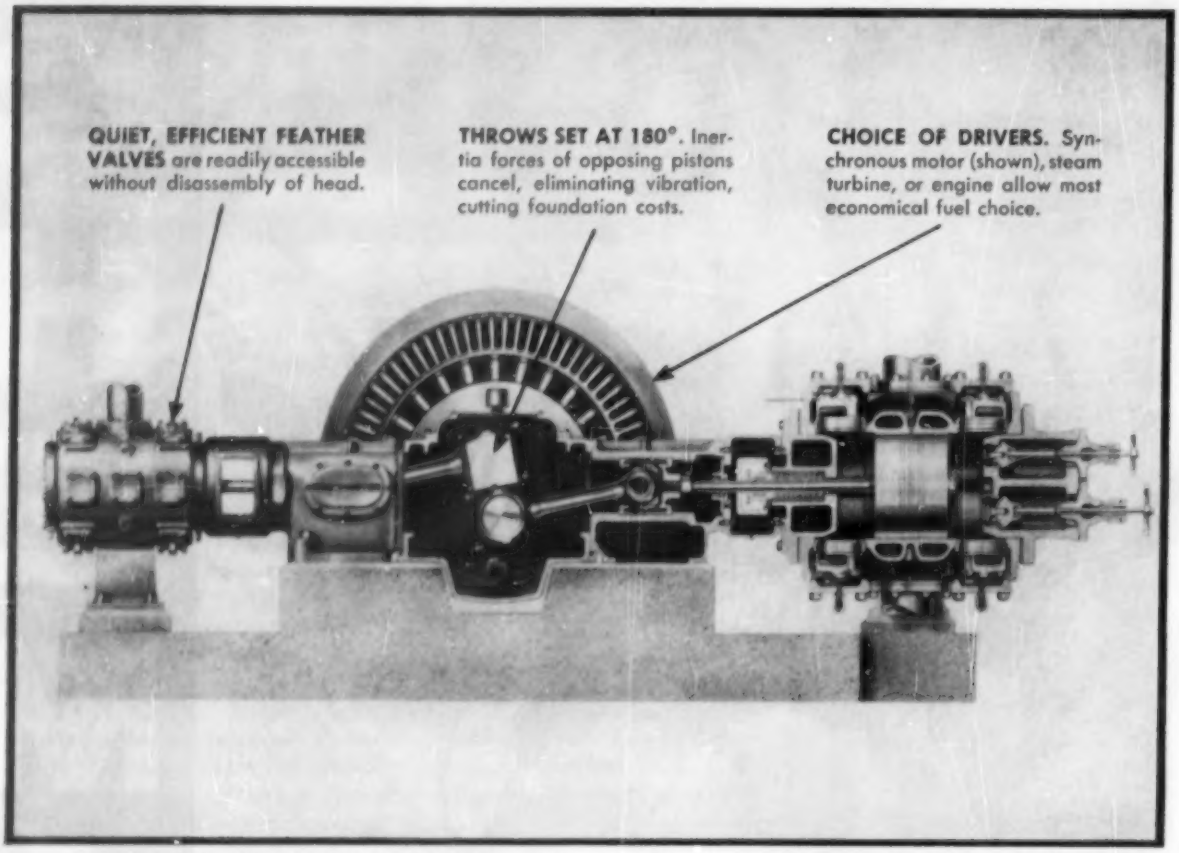
QUIET, EFFICIENT FEATHER VALVES are readily accessible without disassembly of head.
THROWS SET AT 180°. Inertia forces of opposing pistons cancel, eliminating vibration, cutting foundation costs.
CHOICE OF DRIVERS. Synchronous motor (shown), steam turbine, or engine allow most economical fuel choice.

CUTAWAY VIEW of Worthington's new balanced-opposed compressor shows double-throw crankshaft with cranks set at 180 degrees. Reciprocating weights of pistons always travel in opposite directions, cancelling out all inertia forces. Result: fewer vibration problems; consequently, simpler foundation.

New balanced-opposed compressor handles multi-services all at once

When you have process requirements existing at different low-temperature levels, you don't need a battery of compressors. All you need is one Worthington balanced-opposed unit — with only one driver.

The new balanced-opposed compressor is specifically designed to handle single or cascade refrigeration duties. What's more, you can combine on the same frame refrigeration loads with gas compression, similar to that encountered in chlorine condensing and carbon dioxide liquefaction systems. Result: a big saving in installation and operating costs.

Here are more cost-cutting features:

BALANCED-OPPOSED PRINCIPLE (which virtually eliminates transmission of unbalanced shaking forces to foundation) plus simple frame design permit use of smaller, less expensive foundation.

FEATHER* VALVE OPERATION. Worthington's exclusive Feather Valve provides unusually high compression efficiency — bringing power costs 'way down.

MINIMUM MAINTENANCE COSTS — made possible by quick, easy accessibility to all compressor cylinders and running gear.

WIDE CHOICE OF DRIVERS — synchronous motor, steam turbine, internal combustion engine — whatever drive is easiest, cheapest for you to use.

You can get the Worthington balanced-opposed compressor in sizes from 300 HP all the way up to 10,000 HP. Write for details today to Worthington Corporation, Air Conditioning and Refrigeration Div., Section A.5.60-PE, Harrison, N.J. A.5.60

*Reg. U.S. Pat. Off.

WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Forge Steel Union and Check Valve Data Booklet

Complete data on various types of forged steel unions and check valves are contained in a new booklet now being issued by Clayton Mark & Company. Cutaway views and sectional drawings supplement detailed descriptions and specifications, including tabulated dimensions, weights, pressures and temperature ratings and other pertinent data of each type of forged steel union and check valve.

Of special interest are the pages devoted to the recently introduced "Petro" 304, 316, and 347 stainless steel hot forged unions for screwed or socket weld connections. Similar data is given for stainless steel orifice unions and forged steel union check valves with various trims, also for all brass spring check valves.

"Handle-Bar," 4000 test and 6000 test, unions are given full treatment in this new data booklet. The O Ring type, recommended for cementing, mud, crude oil, gas and water services, has recommendations given as to various type of synthetic rubber compounds best suitable for such applications.

Circle E13 on Postcard

Water treating systems are featured in a new 24-page bulletin now available from Milton Roy Company.

This bulletin, Bulletin 935, describes typical water treating processes including coagulation systems, lime soda softening, hot process softeners, demineralization, and various types of boiler water treatment systems. Thorough analysis is given to cooling tower water treating problems as well as methods and systems for waste and sanitary water treatment.

Your copy is available now. Just . . .

Circle E14 on Postcard

Miniature digital pressure gauges developed by the Byron Jackson Company, Electronic Division, are described in a new bulletin, BJE-606. The Vibrotron gauges described are direct pressure-to-frequency instruments. The gauge measures pressure in terms of the frequency of alternation of an electrical current. This signal may then be transmitted via radio or wire and amplified to useful levels without distorting the original relationship of frequency to pressure. Specifications for Vibrotron models of an absolute pressure gauge and a gauge pressure gauge are presented in the bulletin. A listing of other electronic testing and control instruments from the Byron Jackson Company is also included.

Circle E15 on Postcard

Liquid level gauges are the subject of the new 26-page bulletin just released by the Bristol Company. The well illustrated, two color bulletin shows float-type, pressure-type, differential pressure-type, and bubbler-type liquid level gauges, in both strip and round chart models. Air or electric controllers are available in several modes.

A new weatherproof case is shown for the 8- and 12-inch round chart recorders and controllers. These are designed for surface or pole mounting outdoors where the instrument will be exposed to all types of weather.

Engineering data on the choice of the proper bulb, and instrument for a given installation are presented, as well as installation information on liquid level telemetering and remote control.

Your copy of this bulletin, L701, is available now. Just . . .

Circle E16 on Postcard

Glycols are the subjects of a new 60-page book just published by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. The 12 commercial glycols and tiols sold by the company are discussed in detail.

The book is a handy reference for chemists, engineers, purchasing agents, and production and laboratory workers. It describes the uses and suggested applications for glycols. Tabular data include properties, shipping information, specifications, test methods, and constant boiling mixtures. Useful physical property data are contained in 33 easy-to-read charts. A selected list of references gives the reader sources for additional and more detailed information.

This book is available at no charge. Simply . . .

Circle E17 on Postcard

Valve types manufactured by Shutte and Koerting are shown in the company's new bulletin, V-1. The bulletin illustrates and describes Shutte and Koerting's line of Bleeder Check, Boiler Feedwater, Venturi Reducing, Heater Bypass, Balanced Butterfly, and Atmospheric Relief Valves and a new high pressure, Forged Strainer. It includes information on the company's designs and their specific advantages and data on construction and application.

Your copy of this informative bulletin is available now. Simply . . .

Circle E18 on Postcard

Physical and chemical properties of the chloromethanes — methylene chloride, methyl chloride, chloroform and carbon tetrachloride — are contained in a new, comprehensive, 28-page booklet offered by the Solvay Process Division of Allied Chemical and Dye Corporation.

In addition to data applying generally to the chloromethanes, the book contains individual sections that supply specific figures and information on each of the products. Included are such items as toxicity, azeotropic data, flammability, solubility, shipping, handling and storage.

Your copy of this booklet is available without charge, now. Simply . . .

Circle E19 on Postcard

"Corrosion Resistance of Cupro-Nickel Alloys Containing 10 to 30 Percent Nickel" is the title of a new 12-page booklet recently released by the International Nickel Company, Inc.

This book provides considerable tabulated data on performance in specific service in various industrial fluids such as ammoniacal solutions, brines, alkaline solutions, petroleum products, organic compounds, and others.

Your copy is available now. Simply . . .

Circle E20 on Postcard

Industrial applications of aluminum for producing everything from beer to bomb shells are thoroughly analyzed in a new 80-page book published by Aluminum Company of America.

This new book delivers its story in three important phases. Described first are process applications of aluminum by industry and product. Following this is a comprehensive directory of the performance of aluminum with various chemicals. The latest information on designing aluminum processing equipment completes the book.

Part II of "Process Industries Applications of Alcoa Aluminum" is a most useful service dictionary on the performance of aluminum with chemicals. All common chemicals are indexed alphabetically and their effect on aluminum is carefully explained. Also included in this section are process flow charts for the production of important chemical products showing where aluminum equipment is employed.

The book is available by writing on company letterhead to Aluminum Company of America, Department PR, 761 Alcoa Building, Pittsburgh 19, Pennsylvania.

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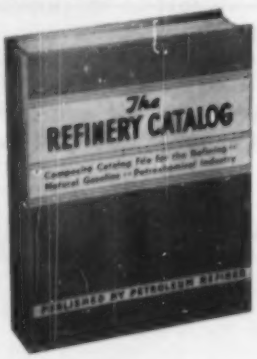
The
REFINERY CATALOG
Complete Catalog File for the Refining and Natural Gasoline Petrochemical Industry
PUBLISHED BY PETROLEUM REFINER

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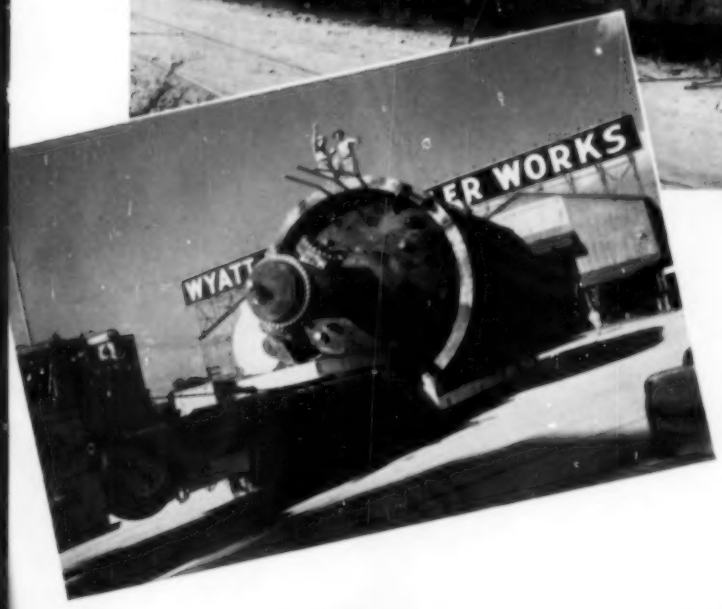

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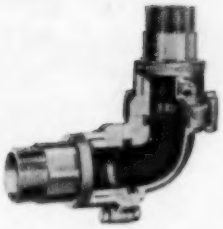

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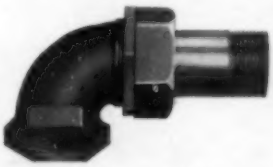

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Plate 889 — Straight Standard Swing Joint. Sizes 1¼ to 4 inches.

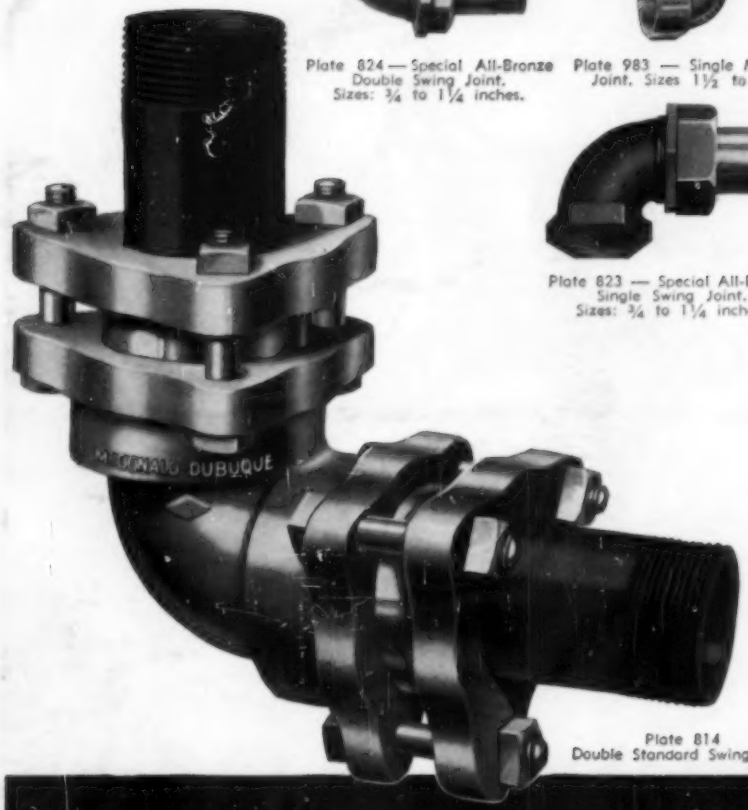
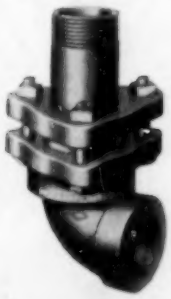


Plate 814 Double Standard Swing Joint.



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